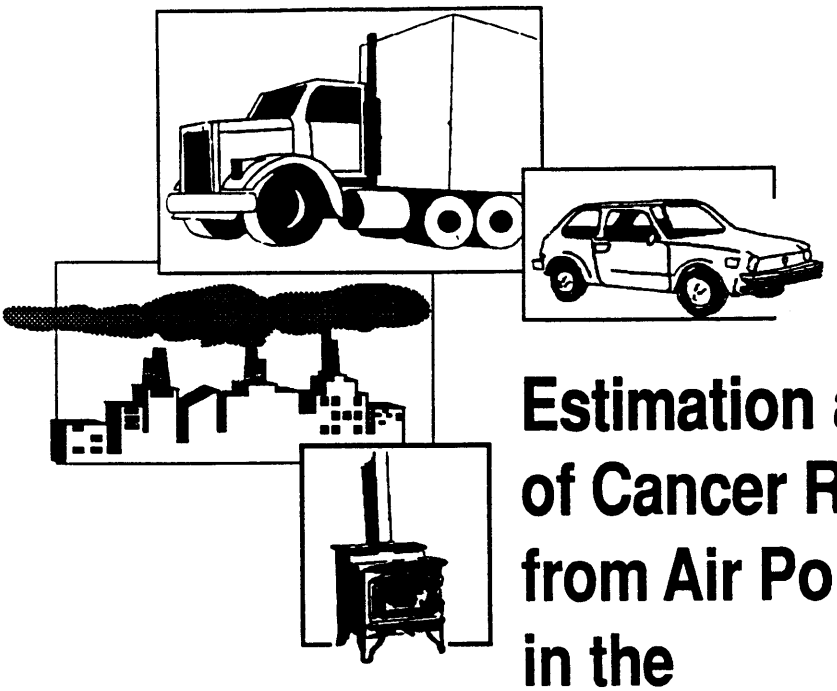
5.10



Estimation and Evaluation of Cancer Risks from Air Pollution in the Minneapolis/St. Paul Metropolitan Area

Prepared by:

Minnesota Pollution Control Agency

Air Quality Division

March 1992

Acknowledgements

This study was completed in large part by Ms. Karen Thirman, who left the Minnesota Pollution Control Agency (MPCA) prior to its publication. We hope she will be pleased by its final form, as the data itself, the study format, and a large part of the report text, is largely her work. She in turn worked closely with Mr. J. Jacob Wind of American Mangement Systems, who was contracted to prepare the study for the MPCA. Ms. Thirman would certainly wish to acknowledge that work in the final report.

The study would not have been completed without the help of Mr. Leo Raudys who was willing to learn and able to work with the computer systems integral to the project. He is responsible for most of the graphics. His perserverence is commendable.

We also wish to recognize Mr. Tom Lahre with the U.S. Environmental Protection Agency (EPA) for his input to the project. His advice was indispensable.

Inquiries

Inquiries on the final report should be directed to Ms. Elizabeth Henderson, Staff Engineer with the Air Quality Division of the MPCA. She can be reached at (612) 296-7597.

EXECUTIVE SUMMARY

The Minnesota Pollution Control Agency (MPCA) has completed a study of the amount of potentially **cancer-causing pollutants** that are released into the air by various sources in the **Twin Cities metropolitan area.** The purpose of the study was to analyze sources of air pollutants suspected or known to cause cancer, and estimate the health risk from exposure to these pollutants.

MPCA staff began by examining sources of pollutants in the entire seven-county metropolitan area. This area is called the study area.

MPCA staff inventoried emissions from **point sources** (large industrial facilities like manufacturing or power production), **area sources** (small but numerous facilities like dry cleaners and gas stations), and **mobile sources** (cars and trucks). Computer models were used to estimate the amount of selected pollutants from these sources that would be present in the surrounding, ambient air, and determine the health risks of long-term exposure to these pollutants.

Health risk results were calculated for the area bounded by I-694 and I-494 on the east, I-694 and I-94 on the north, I-494 on the west, and I-494 and Mendota Road on the south. **This area is called the receptor area.**

The study results showed that the average cancer risk resulting from exposure to the selected pollutants is **2.26 additional cancer cases per year for each million Twin Cities residents.** Five other urban areas studied by the U.S. Environmental Protection Agency (EPA) showed an average cancer risk from 2 to 10 excess cases per million per year.

The study did not calculate maximum individual risks - such as might be experienced by an individual living next to a specific facility or conducting activities nearby. Rather the study calculated average risks over the receptor area.

The study identified sources of pollution that contribute to the 2.26 additional cancer cases per year per million people. Of most significance are **motor vehicles,** which contribute 61 percent of the risk, and **wood stoves and fireplaces,** which contribute 17 percent of the risk (Figure VII-1).

The study also identified pollutants that contribute to the cancer risk. Of most significance are diesel particulates with 27 percent of the cancer risk, gasoline particulates at 15 percent, and wood stove particulates at 15 percent (Figure VII-2). These results are consistent with the identified sources.

At 61 percent, motor vehicles in the Twin Cities account for a higher share of the additional cancer risk than the 55 percent average contribution for the five cities studied by the EPA. As a source of cancer-causing pollutants, wood stoves and fireplaces play a larger role in the Twin Cities than they do in other cities studied by EPA where the average contribution is six percent.

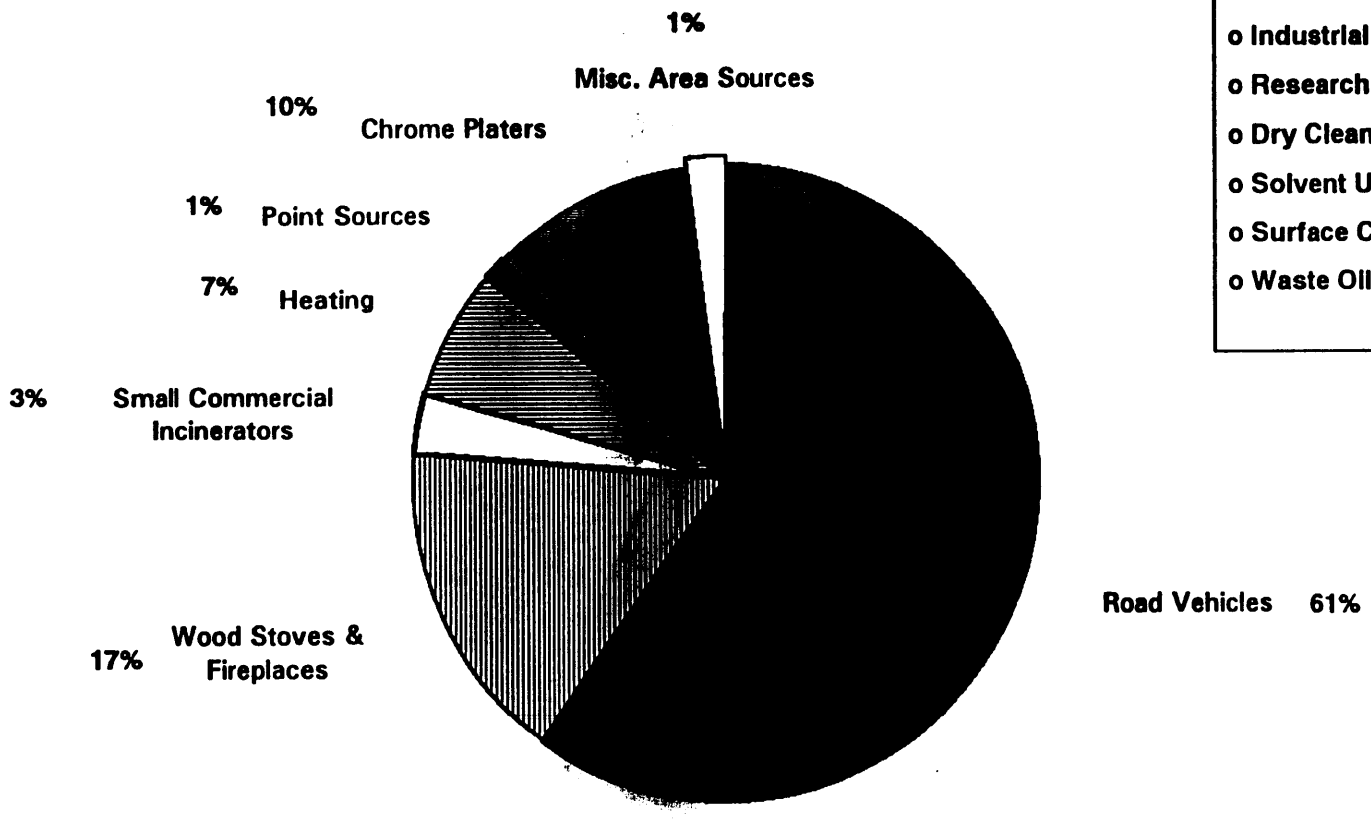
Point sources in the Twin Cities seem to play a smaller role (about one percent of the additional cancer risk) than they do in other cities where point sources contribute an average of eight percent of the cancer incidence. Given that fewer point sources of cancer-causing pollutants like those that contributed to risk in other studies are located in the Twin Cities receptor area, this result is not surprising. However, there are major point sources of carcinogenic pollutants located within the 7-county area but outside of the receptor area. These sources were not fully assessed by this study.

The specific effects of individual point sources on nearby residents was not calculated in this study. This can be an important issue with respect to risk from point sources.

While the study cannot pinpoint specific locations that have the highest risk, the area-wide results are a reasonable estimate of cancer risk from air pollution in the Twin Cities. The sources of cancer exposure identified by this study are significant and worthy of future attempts to reduce their emissions.

Total Estimated Excess 70 Year Cancer Incidence = 222

= 2.26 excess cancer cases/year/million population in receptor area



Misc. Area Sources **Includes:**

o Comfort Cooling Towers	37%
o Degreasing	26%
o Small Hospitals	16%
o Gas Marketing	6%
o Industrial Cooling Towers	6%
o Research Labs	5%
o Dry Cleaners	1%
o Solvent Usage	1%
o Surface Coating	1%
o Waste Oil Burning	1%

Figure VII-1. Estimated excess cancer incidence by source category.

Total Estimated Excess 70 Year Cancer Incidence = 222

= 2.26 excess cancer cases/year/million population in receptor area

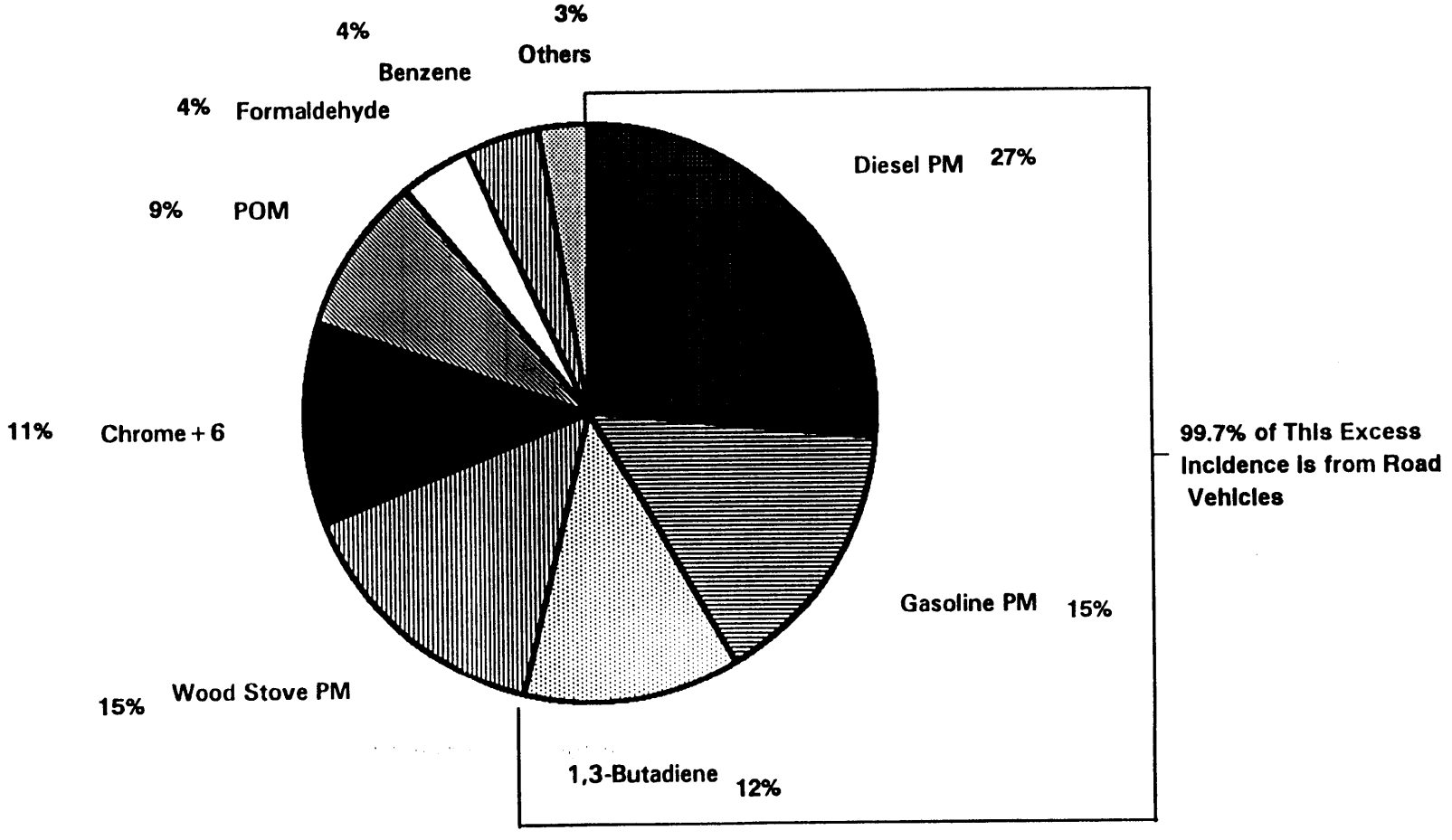


Figure VII-2. Estimated excess cancer incidence by pollutant.

I. OVERVIEW

There is increasing national concern that elevated cancer incidence may result from the effects of multiple source, multiple pollutant situations that characterize densely populated urban areas. In response to this concern, the Minnesota Pollution Control Agency (MPCA) conducted a screening study to evaluate this situation in the Minneapolis-St. Paul metropolitan area. The study was designed to estimate and characterize emissions of selected pollutants, and to model the resulting human health risk.

The elements of this study can be outlined as follows:
A. Definition of study area.
B. Selection of pollutants to be studied.
C. Development of an inventory of emissions on those pollutants.
D. Estimation of concentrations of those pollutants in the ambient air.
E. Estimation of risk due to the ambient concentrations.

The study area consists of a "source area" and a "receptor area". The emissions "source area" is the area where emissions originated. The "receptor area" is the area where health impacts from emissions in the source area were estimated. The emissions source area defined in the study is the seven-county metropolitan area which includes Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington counties (see Map II-1). The emissions receptor area modeled in the study is defined as all Census Block Enumeration Districts (CBEDs) within the area bounded by I-694 and I-494 on the east, I-694 and I-94 on the north, I-494 on the west, and I-494 and Mendota Road on the south (see Map II-2).

Pollutants generally of interest in similar studies are referred to as air toxics. Cancer incidence was defined as the end point of interest in this study. Therefore, the air toxics selected for analysis are carcinogens and suspected carcinogens for which dose-response relationships have been estimated by the Environmental Protection Agency (EPA) (see Table III-1).

The MPCA developed an emissions inventory that includes point, area and mobile sources in the source area of the selected air pollutants. **Point sources** are sources of emissions from generally large industrial or institutional facilities (power production, industrial processes, etc.). **Area sources** are sources of emissions that are generally smaller but occur more frequently (drycleaners, gasoline service stations, etc.). **Mobile sources** are vehicular.

A goal of this study was to develop, within the constraints of the project, the most comprehensive emissions inventory possible. The study attempted to include all large sources of air toxics emissions in the source area.

After developing the emissions inventory, the next step of the study, was the estimation of ambient concentrations of the selected pollutants in the receptor area due to emissions in the source area. This was accomplished by computer modeling of the emissions in the source area.

The final step was risk estimation from ambient concentration estimates determined in the modeling step. This resulted in the creation of a risk-screening data base of modeled concentrations, individual risks and population incidence within the modeling domain.

The development of pollutant concentrations and risk estimates in urban air toxic studies requires extensive data handling. This study used a computerized data handling system known as PIPQUIC (Program Integration Project Queries Using Interactive Commands) to store and analyze the air emissions data.

It is important to emphasize that this is a screening study. There is a great deal of uncertainty in the methodologies used in both creating the emissions inventory and in modeling the data. Therefore, these uncertainties need to be kept in mind when interpreting the results of this study. Risk estimates should be viewed as order of magnitude approximations and are best used in comparison with similar studies. They are not intended as precise predictions of cancer incidence.

When designing an urban air toxics study, the issue of monitoring versus modeling needs to be discussed. There are advantages and disadvantages to each, and the best method is to incorporate both into a comprehensive study to minimize the weaknesses in using either method alone. Using ambient monitoring to estimate population exposures is a direct method of measurement. Monitoring also allows for the measurement of secondarily formed pollutants such as formaldehyde and background levels of stable pollutants such as carbon tetrachloride. Yet, these analyses tend not to be representative of long-term, area-wide exposure conditions typically modeled in cancer assessments. In addition, ambient monitoring is expensive and can be inaccurate, especially when measuring low levels of air toxics. In contrast, modeling allows for analysis of a broad group of pollutants, sources and receptors but is highly uncertain (see section on uncertainties). Using both methods in an urban air toxics study, can increase the accuracy of the emissions inventory dispersion model.

However, very little ambient monitoring data are available for the receptor area and pollutants included in this study. Therefore, this study does not utilize ambient data.

II. STUDY AREA

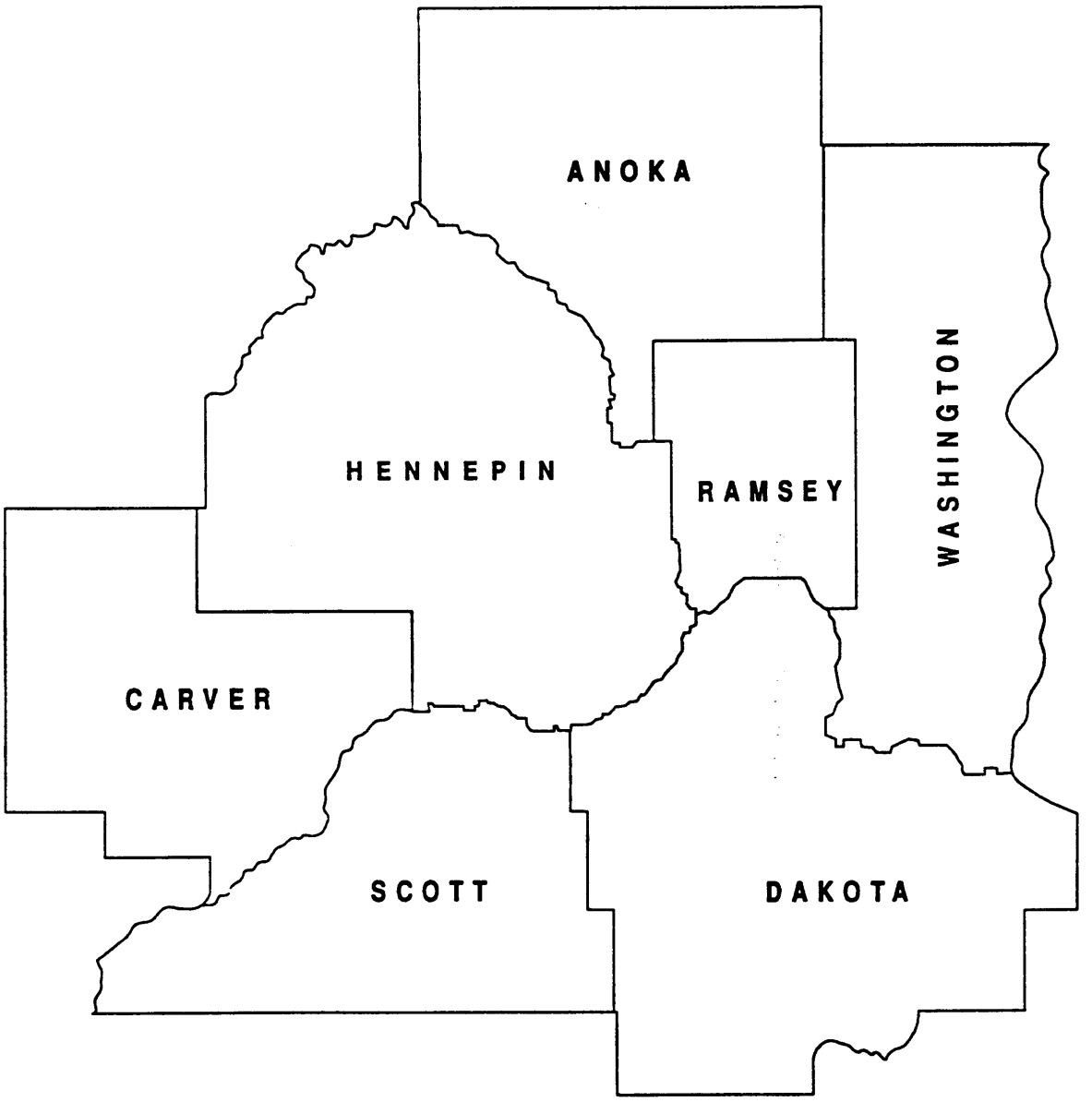
The study area consisted of two overlapping sections - the source area and the receptor area. The source area is the area where emissions originated and were estimated. The receptor area is the area for which cancer incidence from emissions from the source area were estimated.

In an attempt to include the major sources of air toxics emissions, a source area much larger than the receptor area was defined. The source area was defined as Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties (see Map II-1). The emissions receptor area is the area within the rectangle bounded by I-694 and I-494 on the east, I-694 and I-94 on the north, I-494 on the west, and I-494 and Mendota Road on the south (see Map II-2).

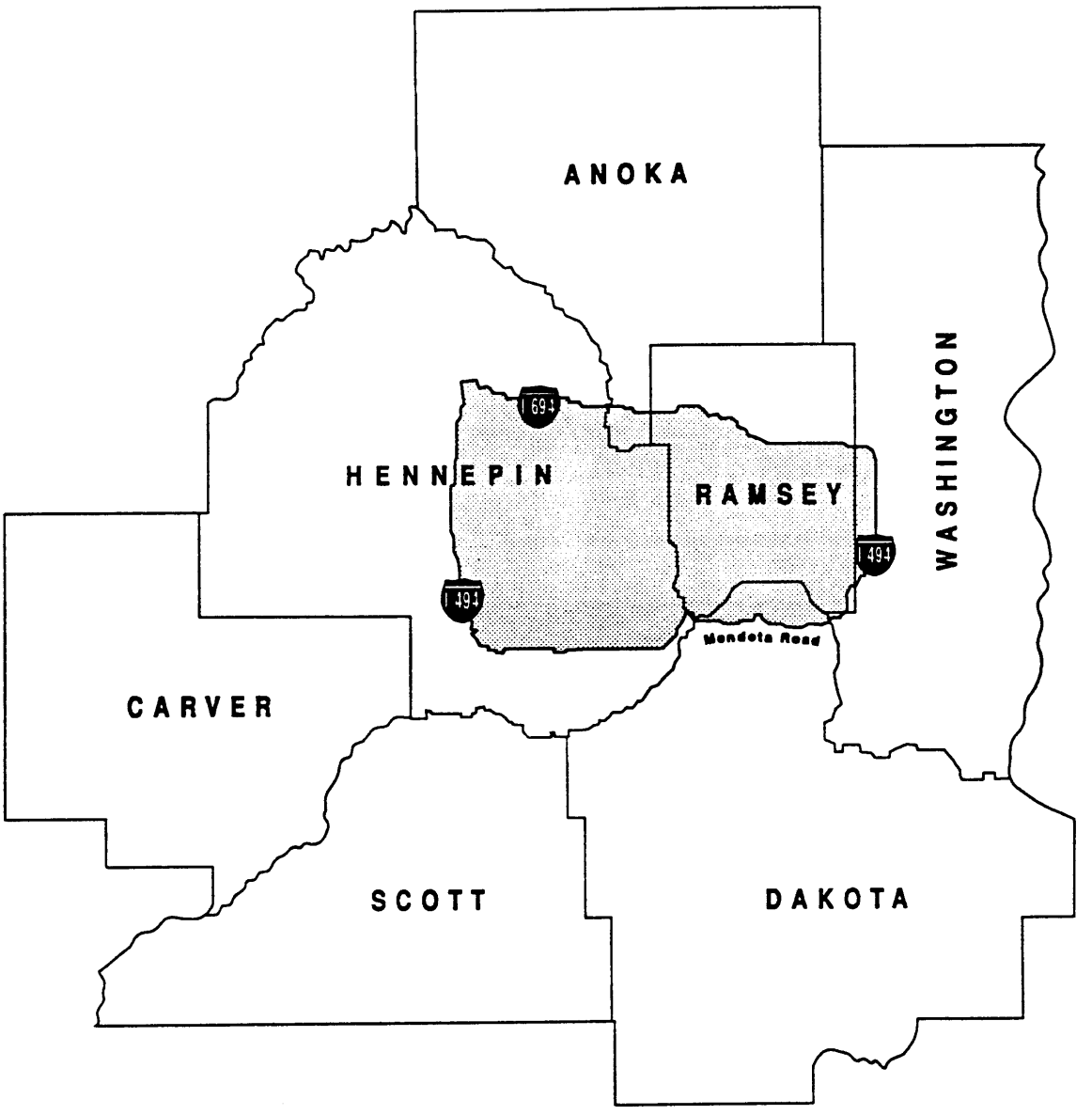
The receptor area was further refined by use of census tracts in emissions estimation and air dispersion modeling. The receptor array used in modeling was defined as the census tract centroids located within the receptor area.

Census tracts consist of block groups or enumeration districts (BG/ED). A block group is an area with an average population of about 1,100. Enumeration districts are areas with an average of 800 people and are used when block groups are not defined.

II-1 Study Area



II-2 Receptor Area



III. POLLUTANTS STUDIED

Table III-1 lists the carcinogenic pollutants inventoried and the unit risk estimates (UREs) used in this study. These are air pollutants for which dose-response relationships for carcinogenicity have been estimated by the Environmental Protection Agency. Pollutants considered to be carcinogenic and their associated UREs vary over time as new data becomes available. The UREs used here were developed at the time this study was begun. Therefore, it may not represent the most current information.

Carcinogens were chosen for this study for a number of reasons. Generally there is more information on carcinogens. It is easier to compare the effects of all carcinogens as the endpoint is the same - cancer. Including noncarcinogens would have required significantly more resources. In addition, limiting the study to carcinogens is consistent with and therefore comparable to other urban air toxics studies.

The treatment of several carcinogenic pollutants modeled in this study requires additional discussion. First, with respect to formaldehyde, evidence has shown that a large percentage of ambient formaldehyde results from photochemical reactions (secondary formaldehyde production) as opposed to direct emissions (primary formaldehyde). Second, carbon tetrachloride is very stable in the atmosphere and thus the ambient concentration may be more a function of past emissions than of current modeled emissions. Therefore, it is very difficult to assess ambient levels of these pollutants by emissions inventory and dispersion modeling alone. The use of ambient air monitoring data for these pollutants is preferred. However,because monitoring results were not yet available at the time this report was written, secondary formaldehyde formation and background carbon tetrachloride information are not included in this study.

The term polycyclic organic matter (POM) is applied to a large group of organic compounds containing two or more fused aromatic rings. A subset of POMs is a group called polycyclic aromatic hydrocarbons (PAHCs). The PAHCs are the most commonly encountered POMs and there tends to be more information on them as a group than on other POMs. In some cases PAHC emissions data were available and in other cases POM emissions data were available. Whichever data were available were included in the inventory.

Chrome is a major contributor to cancer risk in most urban air toxics studies. Chrome exists in several different oxidation states ranging from

-2 to +6. The most common oxidation states are trivalent and hexavalent (+3 and +6). It is assumed that only the hexavalent form of chrome is carcinogenic.

The last pollutant for discussion is nickel. In this study, it was assumed that none of the nickel emissions were in the carcinogenic refinery dust or subsulfide forms, so a unit risk estimate of zero was assigned to all nickel emissions.

TABLE III-1

POLLUTANTS INCLUDED IN INVENTORY AND THEIR UNIT RISK ESTIMATES

I. CARCINOGENS

URE*	CAS	COMPOUND	WEIGHT OF EVIDENCE
2.2E-6	75-07-0	ACETALDEHYDE	B2
6.8E-5	107-13-1	ACRYLONITRILE	B1
4.3E-3	7440-38-2	ARSENIC	A
8.3E-6	71-43-2	BENZENE	A
1.7E-3	50-32-8	BENZO(a)PYRENE (BaP)	B2
2.4E-3	7440-41-7	BERYLLIUM	B2
2.8E-4	106-99-0	1,3-BUTADIENE	B1
1,8E-3	7440-43-9	CADMIUM	B1
1.5E-5	56-23-5	CARBON TETRACHLORIDE	B2
2.3E-5	67-66-3	CHLOROFORM	B2
1.2E-2	7440-47-3	CHROME-6	A
6.2E-4		COKE OVEN EMISSIONS	A
2.6E-5	107-06-2	1,2-DICHLOROETHANE (Ethylene Dichloride)	B2
5.0E-5	75-35-4	1,1-DICHLOROETHYLENE (Vinylidene Chloride)	C
1.2E-6	106-89-8	EPICHLOROHYDRIN	B2
2.2E-4	106-93-4	ETHYLENE DIBROMIDE	B2
1.0E-4	75-21-8	ETHYLENE OXIDE	B1
1.3E-5	50-00-0	FORMALDEHYDE	B1
6.6E-7		GAS VAPORS (MARKETING)	B2
4.9E-4	118-74-1	HEXACHLOROBENZENE	B2
4.7E-7	75-09-2	METHYLENE CHLORIDE	B2
0.0E-0		NICKEL**	A
5.8E-7	127-18-4	PERCHLOROETHYLENE (Tetrachloroethene)	B2
1.7E-3		POLYCYCLIC ORGANIC MATTER (POM)	
3.7E-6	75-56-9	PROPYLENE OXIDE	B2
5.7E-7	100-42-5	STYRENE	B2
3.3E+1	1746-01-6	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	B2
1.7E-6	79-01-6	TRICHLOROETHYLENE	B2
4.1E-6	75-01-4	VINYL CHLORIDE	A

II. CARCINOGENS USING COMPARATIVE POTENCY FOR POM

URE*	SUBSTANCE
3.0E-5***	- DIESEL PM
2.9E-4***	- GASOLINE PM
1.0E-5***	- WOOD STOVE PM

*URE = UNIT RISK ESTIMATE (LIFETIME RISK/UG/CUBIC METER) (the probability of contracting cancer as the result of constant exposure over 70 years to an ambient concentration of 1 microgram per cubic meter)
**URE for Nickel is listed as 0.0 E-0 because it is assumed in this study that none of the nickel emitted is in the carcinogenic refinery dust or subsulfide forms.
***PARTICLE UNIT RISK ESTIMATE (LIFETIME RISK/UG/CUBIC METER)

IV. EMISSIONS INVENTORY

The emissions inventory can be divided into three main sections: point sources, area sources and mobile sources. Following is a discussion of the methods used for each of these source types.

When developing an emissions inventory a distinction needs to be made between point sources and area sources. Ideally, given unlimited resources and computer ability, all sources would be treated as point sources since there is almost always some defined emission point (stack or release point). However, due to a wide variety of constraints, only larger sources with adequate emissions point information were treated as point sources. Smaller emitters were grouped together and modeled as area sources.

In this study, facilities with data from the National Emissions Data System (NEDS) or that reported emissions to the Toxic Release Inventory (TRI) were treated as point sources. Generally, large groups of small quantity emitters were inventoried as area sources. Area source categories also were chosen based on previous studies that identified them as high risk source categories.

When population data was needed for the calculation of emissions, the following data was used:

County	Population*	% Population
Anoka	195,998	9.9%
Carver	37,046	1.9%
Dakota	194,274	9.8%
Hennepin	941,411	47.4%
Ramsey	459,784	23.1%
Scott	43,784	2.2%
Washington	113,571	5.7%
Total	1,985,873	

*Source: 1980 Census Data

1. POINT SOURCES

Methodology

Due to resource limitations, only readily available data were used in developing the point source emissions inventory. Nevertheless, the study attempted to create a comprehensive data base of major point sources.

One hundred eighty one (181) facilities were included in the inventory.

There were two main sources of point source data - TRI and NEDS. The NEDS database contains criteria pollutant emissions data and stack parameters. **Criteria pollutants** are pollutants for which ambient air quality standards exist at this time. The criteria pollutants at this time are carbon monoxide (CO), oxides of sulfur (SOx), oxides of nitrogen (NOx), particulate matter less than or equal to 10 microns (PM10), volatile organic compounds (VOCs) - treated as a group in order to control low level atmospheric ozone levels), - and lead. Substances emitted which are not criteria pollutants are called non-criteria pollutants, or often, simply, "air toxics".

Criteria pollutant emissions are estimated for each stack in the NEDS data base using the following formulas:

1) For each stack, emissions of lead and volatile organic compounds = emission factor x fuel usage x (1-control fraction)

2) For each stack, emissions of total suspended particulates (TSP) = emission factor x fuel usage x ash content x (1- control fraction)

The inventory is prepared every 2 years by the MPCA as required by MPCA rules for facilities which actually emit greater than 25 tons per year of a criteria pollutant. The1986 emissions inventory for Minnesota was used in the preparation of this study. That was the latest information available at the time during which the bulk of the work for this study was conducted.

Air toxics emissions were estimated, by stack, from the above criteria pollutant estimates using species profiles (Air Emissions Species Manual, Volume 1 - Volatile Organic Compound Species Profiles and Volume II - Particulate Matter Species Profiles, Office of Air Quality Planning and Standards, USEPA.). These species profiles only present data for a "typical" facility for a given SCC (source classification code) and emissions from an individual source may be substantially different from the data presented in the profile. Source specific data (TRI or MPCA specified data), where available, are always preferred over speciated data.

Emissions were estimated by stack, SCC, and chemical using the following formula:

Air toxics emissions = emissions of VOC and TSP x species fraction based on SCC for each chemical

For example, for SCC = 10200401 (external combustion boiler), the speciation profile indicates that formaldehyde is 42% by weight of VOC

emissions. Thus, for a stack with 100 lb/yr of VOC emissions (from criteria pollutant emissions inventory), 42 lb/yr were assumed to be formaldehyde.

The second source of data used to estimate air toxics emissions from point sources was the 1988 TRI data base. The TRI database is developed in accordance with Title III of the Superfund Amendments and Reauthorization Act (SARA). Section 313 of SARA Title III requires manufacturers with Standard Industrial Classification (SIC) codes 20-39, who manufacture, process or otherwise use greater than specified threshold quantities of listed substances, to submit an annual report of releases to all environmental media.

A number of facilities had both NEDS data **AND** TRI data. For these facilities, it was assumed that, when there were overlapping data, the TRI data were more reliable than the speciated NEDS data. The TRI data are, at the very least, a best guess made by someone familiar with the facility. In contrast, speciated NEDS data are, at best, a rough estimate of the "typical" air toxics emissions from a given SCC without any site-specific input.

The two data files were merged as follows:

1) If a facility ONLY had NEDS data, the speciated data were used as is.

2) If a facility ONLY had TRI data, these data were used.

3) If a facility had BOTH NEDS and TRI data:

a. For a compound reported in both data bases, the total amount of that compound emitted was assumed to be equal to the amount reported in TRI. That total quantity was then apportioned to the appropriate stacks using NEDS stack data and the following formula:

$$\text{Emissions of TRI chemical A from stack Y} = \text{NEDS emissions of chemical A from stack Y} \times \frac{\text{Total emissions of chemical A from TRI}}{\text{NEDS total emissions of chemical A from all stacks at that facility}}$$

b. For compounds appearing only in NEDS or only in TRI, the data were used without modification.

Example Calculation:

Facility ABC has both NEDS data and has reported under TRI.

Speciated NEDS data=		TRI data =	
Stack 1:	100 lb/yr chemical A	Chemical A:	400 lb/yr stack emissions
	50 lb/yr chemical B		100 lb/yr fugitive emissions
Stack 2:	100 lb/yr chemical A	Chemical C:	100 lb/yr stack emissions
			100 lb/yr fugitive emissions

Results of merging the two data bases and apportioning emissions:

Chemical A:	Stack 1 - 250 lb/yr
	Stack 2 - 250 lb/yr
Chemical B:	Stack 1 - 50 lb/yr
Chemical C	Default Stack* - 200 lb/yr

*Refer to Section V. Air Dispersion Modeling for details on default stack parameters.

MPCA Specified Data:

In addition to the above point source databases , three additional types of data were used. First, for the Ford Motor Company Twin Cities Assembly Plant, source specific emissions data were used. This was the only point source for which source specific air toxics emissions data were available.

Second, a special survey was conducted for the largest hospitals in the Twin Cities metropolitan area to determine ethylene oxide emissions. The largest hospitals (as determined by American Hospital Association data on the number of beds per hospital) were telephoned to estimate the quantity of ethylene oxide sterilant used in the most recent calendar year. This information generally was obtained from the purchasing departments of the hospitals. These large hospitals were modeled as point sources. The remaining smaller hospitals' ethylene oxide emissions were determined using emission factors and were modeled as area sources.

Third, emissions from the Hennepin Energy Resource Corporation (HERC) were input to the system as point source emissions. This was done because HERC is sufficiently new that the facility was not included in the 1986 emission inventory. Further, its emissions are not reportable under TRI. However, because of the level of public interest in the facility, it was deemed important to include it. Please note that HERC is NOT included in the area source category - small commercial incinerators (sometimes abbreviated as "incineration"). HERC emissions are included in the point source inventory, based on tested emissions.

Thus, the data hierarchy used in this study was:

MPCA specified data	>	TRI data with overlapping NEDS data	>	TRI data alone	>	NEDS data alone

Hexavalent Chrome:

Hexavalent chrome is the only species of chrome that is considered to be carcinogenic. Therefore, it was necessary to have emissions estimates for hexavalent chrome. Emission factors for hexavalent chrome are available for chrome platers and cooling towers and were used. However, factors for hexavalent chrome are not readily available for other sources. Laboratory methods for determining emissions of hexavalent chrome from most point sources are only now being developed. The NEDS speciated data only provides data on total chrome emissions. Therefore it was necessary to attempt to estimate the percent of those total chrome emissions that are hexavalent.

Additional work was conducted to determine the likelihood that part of the various total chrome emissions were hexavalent chrome. Detailed information on this work is included in Appendix C. In general the result of this work was to assume that 0.5% of municipal solid waste incinerator total chrome emissions are hexavalent chrome and that 1% of coal burning, oil burning, or heated process total chrome emissions are hexavalent chrome.

Uncertainties

There are many sources of uncertainty in the development of this point source emissions inventory. For the most part, only readily available data were used. Estimating lead, VOC and TSP emissions using the described formulas, while standard practice, does not yield exact results. Speciation of VOC and TSP data is at best an approximation. Emissions from an individual source may vary significantly from the species profiles, which are often based on national averages. In addition, the quality of the profiles varies considerably from being based on sampling and analysis with full documentation to being based solely on engineering judgement. The variability in the data quality is not reflected in this study. The Air Emissions Species Manual cautions against using species profiles to

characterize specific sources. Species profiles are best used for screening purposes and source specific data are always preferred over speciated data.

An attempt was made to reduce the uncertainty in the use of the speciation data. The species data include a profile number "0000" which is the average of all speciated emissions data from all sources included in the manual. This profile is used in the EPA published speciation data when no better data exists. However, it was determined that these data were too generalized for use in this study. Therefore, this profile was excluded from use in this study.

The TRI data also present a number of uncertainties and limitations that need to be noted here. First, the majority of the data reported are based on estimates and not on actual measurements. In some cases facilities were allowed to report a range of emissions rather than the actual emissions. Where facilities reported 0-499 lbs/yr TRI assumed 250 lbs/yr. Where facilities reported 500-999 lbs/yr, TRI assumed 750 lbs/yr. So far there have been few studies to determine the accuracy of the reported data. Second, not all toxic chemicals or sources of toxic chemical releases are covered under Section 313. Therefore, a company that is required to report may not have to report all of its toxics emissions. For example, some emissions may not be required to be reported because the use of the chemical is less than the threshold. Third, the data only show annual emissions. There is no information on the rate of release or stack parameters.

The method used for apportioning TRI emissions over the NEDS stacks, while probably a good approximation, may be inaccurate in specific. TRI emissions might actually apply to only one or two stacks instead of being apportioned over more stacks based on NEDS emission estimates. In addition, TRI fugitive emissions might not apply to NEDS emission points. Another source of uncertainty is that matching TRI facilities to NEDS facilities was often difficult due to differences in how a company's name was reported. As this correlation was done manually for this study, it is possible that overlapping data might have been missed which would have resulted in double counting of emissions. Also, TRI chemical categories such as "lead compounds" were matched against NEDS speciated "lead" which may be inaccurate. Lastly, many TRI facilities lacked good locational data which are required for good dispersion modeling.

Some of the uncertainties in the point source emissions inventory could be reduced if additional staff time for research or better source data were available. This is especially true for facilities with emissions derived from poor quality species profiles.

2. AREA SOURCES

Methodology

Appendix B to this document contains a detailed discussion of the estimation procedure used for each area source inventoried in this study. Area sources included in the study are listed below:

I. Service Station Gasoline Emissions
II. Drycleaning Emissions
III. Ethylene Oxide Sterilizers
    A. Hospital Ethylene Oxide Sterilizers
    B. Research Laboratories Ethylene Oxide Sterilizers
IV. Industrial Cooling Towers
V. Comfort Cooling Towers
VI. Chrome Plating
VII. Surface Coating
VIII. Degreasing
IX. Commercial/Consumer Solvent Use
X. Small Commercial Incinerators
XI. Waste Oil Combustion
XII. Industrial Area Source Heating
    A. Distillate Oil
    B. Natural Gas
XIII. Commercial/Institutional Heating
    A. Distillate Oil
    B. Residual Oil
    C. Natural Gas
XIV. Residential Heating
    A. Distillate Oil
    B. Natural Gas
XV. Residential Woodburning

The point source inventory necessarily included two parts - emissions estimates and identification of the locations of the emissions. These two pieces of information also needed to be developed for area sources. Therefore, there were two steps in developing the area source emissions inventory. First, the emissions were estimated based on information from a variety of sources (refer to Appendix B). Second, the emissions were assigned a location. Generally the emissions estimates resulted in area wide or county wide emissions values. In order to use these data in further steps of this study the emissions were allocated to census tracts.

The location of area source emissions was done by apportioning emissions to census tracts according to either population or land use data. Data on

land-use acreage for commercial, industrial, single-family residential and multi-family residential zoned areas by census tract for the seven-county metropolitan area were provided by the Metropolitan Council (Linda Tomaselli). These data were used in apportioning area source emissions, depending on the type of emission source. For instance, area wide estimates of drycleaning emissions were apportioned according to population, whereas area wide estimates for emissions from industrial cooling towers were apportioned according to the amount of industrially zoned area. Appendix B includes the apportioning basis for each area source. Table IV-1 is a summary of the area source inventory process.

Uncertainties

In area source emissions inventories there is an inherent uncertainty that comes from treating emissions as area sources versus point sources. When possible, it is better to treat larger area sources as point sources instead of aggregating them with area sources. This is true because the accuracy of air dispersion modeling in estimating ambient concentrations is better for point sources - since it includes specific information on the release (stack, vent etc.). Some of the larger area source facilities such as very large service stations or drycleaners could have been modeled as point sources to reduce some of this uncertainty. In addition, source types such as chrome platers which contribute greatly to overall risk should be modeled as point sources in future efforts. This was not possible in this study due to a lack of specific information on these facilities.

Other sources of uncertainty involve the emission factors used in estimating area source emissions. Some emission factors may be outdated. The emission factors tend to assume uniform activity rates throughout a county which may be inaccurate for some source types. Often the emission factors are based on the assumption that either employment data or population data are good indicators of activity levels. This assumption is probably fairly good for some source types such as dry cleaners and consumer solvent use but is not as good in determining activity levels for other source types such as chrome platers. Occasionally, in determining employment data for some source types, information was not available for specific SIC codes. This required using more generic SIC code information which resulted in conservative estimates of emissions.

Overall, use of the emission factor method in estimating area source emissions is reasonable for the purposes of this screening study. Local surveys of activity levels should be conducted to provide more reliable and accurate data for future studies.

TABLE IV-1
SUMMARY OF EMISSIONS BASIS AND APPORTIONMENT FOR AREAS SOURCES*

AREA SOURCE TYPE	POLLUTANTS CONSIDERED	EMISSIONS BASIS	APPORTIONMENT	SOURCE CATEGORY	STACK CODE IN STUDY
Service Station Gasoline Emissions	Benzene Ethylene Dibromide Ethylene Dichloride	gallons/county from gallons/state x % sales by county x emission factor - varies with pollutant and activity	population	Gas Marketing	G
Drycleaning Emissions	Perchloroethylene	lbs/county from county-wide employment in SIC 721 & 360 lbs/yr/emply.	population	Solvent use	SC
Hospital Ethylene Oxide Sterilizers	Ethylene Oixde	lbs/county from beds/county & lb/bed/yr (varies w/size) - less point sources > 500 lbs/yr	population	Miscellaneous Area Sources	MH
Research Lab Ethylene Oxide Sterilizers	Ethylene Oxide	3.5 lbs/1000 persons	population	Miscellaneous Area Sources	MD
Industrial Cooling Towers	Hexavalent Chrome	lbs/county from county-wide employment in appropriate SIC codes and lbs/yr/employee (varies with SIC code)	industrially zoned area	Cooling Towers	CI
Comfort Cooling Towers	Hexavalent Chrome	0.00198 lb/yr/person	population	Cooling Towers	CC
Chrome Plating	Hexavalent Chrome	lb/county from county-wide employment in appropriate SIC codes (varies with SIC code)	industrially zoned area	Miscellaneous Area Sources	MC
Surface Coating	Trichloroethylene Methylene Chloride	lb/county from county-wide employment in appropriate SIC using lb/yr/employee (varies with SIC code and pollutant) & subtract point sources	industrially and commercially zoned areas	Solvent Use	SS
Degreasing	Perchloroethylene Trichloroethylene Methylene Chloride	lb/county from county-wide employement in appropriate SIC codes & lb/yr/employee (varies with pollutant) & subtract point sources	industrially and commercially zoned areas	Solvent Use	SD

TABLE IV-1 continued
SUMMARY OF EMISSIONS BASIS AND APPORTIONMENT FOR AREAS SOURCES

AREA SOURCE TYPE	POLLUTANTS CONSIDERED	EMISSIONS BASIS	APPROTIONMENT	SOURCE CATEGORY	STACK CODE IN STUDY
Commercial/Comsumer Solvent Use	Perchloroethylene Trichloroethylene Methylene Chloride	lb/yr/capita (varies with pollutant)	population	Solvent Use	SU
Small Commercial Incinerators	POM Benzo(a)pyrene	PCA information	industrially and commercially zoned area	Incineration	IC
Waste Oil Combustion	Arsenic Benzo(a)pyrene Benzene Beryllium Cadium Hexavalent Chrome Formaldehyde Lead Mercury Methylene Chloride Perchloroethylene Trichloroethylene	lbs pollutant/1000 gallons based on 1.67 E6 gallons recycled/reused onsite (emission factor varies with pollutant)	population	Miscellaneous Area Sources	MW

AREA SOURCE HEATING:

FUEL TYPE	SOURCE TYPE	POLLUTANTS CONSIDERED	EMISSIONS BASIS	APPROTIONMENT	STACK CODE IN STUDY
Residual Oil	Commercial/Institutional**	Arsenic Benzo(a)pyrene Beryllium Cadium Hexavalent Chrome Formaldehyde Lead Nickel POMs	Fuel Consumption	Commercially Zoned Area	HCR
Distillate Oil	Industrial, Commercial/Institutional & Residential	same as residual oil	Fuel Comsuption	Industrial Zoned Area Commercially zoned area Residentially zoned area (single and multi-family zoned area	HID HCD HRD

TABLE IV-1 continued
SUMMARY OF EMISSIONS BASIS AND APPORTIONMENT FOR AREAS SOURCES

AREA SOURCE HEATING - continued:

FUEL TYPE	SOURCE TYPE	POLLUTANTS CONSIDERED	EMISSIONS BASIS	APPROTIONMENT	STACK CODE IN STUDY
Natural Gas	Industrial, Commercial/Institutional & Residential	Formaldehyde	Fuel Consumption	Industrial Zoned Area Commercially zoned area Residentially zoned area (single and multi-family zoned area)	HIG HCG HRG
Wood	Residential	POM Formaldehyde Wood Stove Particulate Arsenic Beryllium Cadium	lbs/county from metro area wood consumption data apportioned to county by population; and 65% fireplaces, 35% wood stoves	single-family zoned area	HRS

*For more detail on specific numbers and their sources, see appropriate part of Appendix B.

**It was assumed that all Industrial residual oil use was included in the NEDS data.

3. MOBILE SOURCES

Methodology

Mobile sources of air toxics consistently have been shown to be a major component of risk in urban air toxics studies. In "Air Toxics Emissions and Health Risks from Mobile Sources" (Penny M. Carey and Joseph H. Somers, USEPA, June 1988), the combined effect of the following list of motor vehicle emissions was estimated to add 629-1874 additional cancer cases in 1986 in the United States: diesel particulates, formaldehyde, benzene, gasoline vapors, 1,3-butadiene, acetaldehyde, gasoline particulates, dioxins, asbestos, vehicle interior emissions, cadmium, and ethylene dibromide. Of this list, ethylene, dioxins, vehicle interior emissions, cadmium, and ethylene dibromide are considered to be insignificant contributors to total incidence. According to the same report, mobile sources do not emit significant amounts of dioxins due to low levels of chlorine in fuel. The pollutants included in this study are those that make the greatest overall contribution to total cancer incidence, namely diesel particulates, formaldehyde, benzene, 1,3-butadiene, and gasoline particulates.

Mobile source emissions were estimated using MOBILE4, a computer program, and then speciating the results. MOBILE4 calculates the emissions of hydrocarbons, carbon monoxide, and nitrogen oxides from gasoline fueled and diesel highway motor vehicles. The emissions estimates from MOBILE4 are dependent upon a variety of area-specific conditions such as ambient temperature, speed, and mileage accrual rates.

E.H. Pechan & Associates, Inc. was provided with vehicle mile traveled (VMT) data by functional class for each county in the study area for 1987. These data were obtained from the Minnesota Department of Transportation. Pechan used these data as inputs to MOBILE4 to develop road vehicle emissions estimates of diesel and gasoline particulates, 1,3-butadiene, formaldehyde, and benzene for the seven counties in the metropolitan area. The Minnesota Department of Transportation did not have specific data on vehicle class distribution. Therefore, default values were used when running MOBILE4. Pechan relied on Penny Carey's report (Air Toxic Emissions from Motor Vehicles, EPA-AA-TSS-PA-86-5, USEPA) in determining emission factors used to estimate air toxics emissions.

Due to the absence of more specific data, the emissions estimates were apportioned over the study area based on population. A better method would have been to apportion the emissions based on data reflecting activity levels. This information was not available at the time of this study. Population is probably a reasonable surrogate for apportioning vehicle

emissions with the exception of the downtown area where the actual population is small compared to the amount of motor vehicle activity.

Uncertainties

The uncertainties in this section of the study range from the input data (VMT, vehicle speeds) to the methods used in deriving the emissions estimates (MOBILE4, speciation of MOBILE4 data). More information that is specific to the study area for inputs to MOBILE4 (instead of using the defaults in the program) would decrease the uncertainties to some extent. Vehicle speeds and vehicle class type directly affect motor vehicle emissions. Apportioning emissions based on population, as discussed previously, will provide inaccurate results for the downtown area.

4. RESULTS OF EMISSIONS INVENTORY

The emissions inventory process resulted in a total emissions inventory for the carcinogens considered in this study of approximately 37 million pounds/year.

Figure IV-1 shows the breakdown of the total emission inventory in the source area by source type (point, area, vehicular, etc.) based on total mass of emissions. Figure IV-2 shows the breakdown of the total emission inventory in the source area by pollutant. Table IV-1D in Appendix D contains numeric data from which the Figures IV-1 and IV-2 were derived.

Wood stove particulate matter is the pollutant with the highest emissions in the study, accounting for 37% of the emissions inventory. Diesel particulate matter is second, accounting for 18 % of the emissions inventory. It is important to note that these two "pollutants", along with gasoline particulates, are actually made up of a number of pollutants. However, since data on the pollutants as total particulates are more readily available and more accurate than chemical specific information, and since risk estimates based on the pollutants as total particulates were available, the particulate groups were inventoried in this study.

However, it should be noted that if a stricter inventory was done, these pollutants could be broken down into specific chemical emissions. If this was done, each individual chemical emission would represent a smaller percent of the inventory. This makes it difficult to compare other, chemical specific inventory results to these 'grouped pollutant' results.

Wood stoves represent the highest emitting source category, accounting for 39% of emissions, followed closely by road vehicles with 33%. This is

consistent with the pollutant contribution of these sources. Solvent use is the third highest category, accounting for 17% of emissions.

Point sources accounted for 9.4% of the emissions inventory. Appendix A includes Table IV-1A which lists the 181 point sources included in the inventory.

Percentages of carcinogenic pollutant emissions in study area, allocated by source.

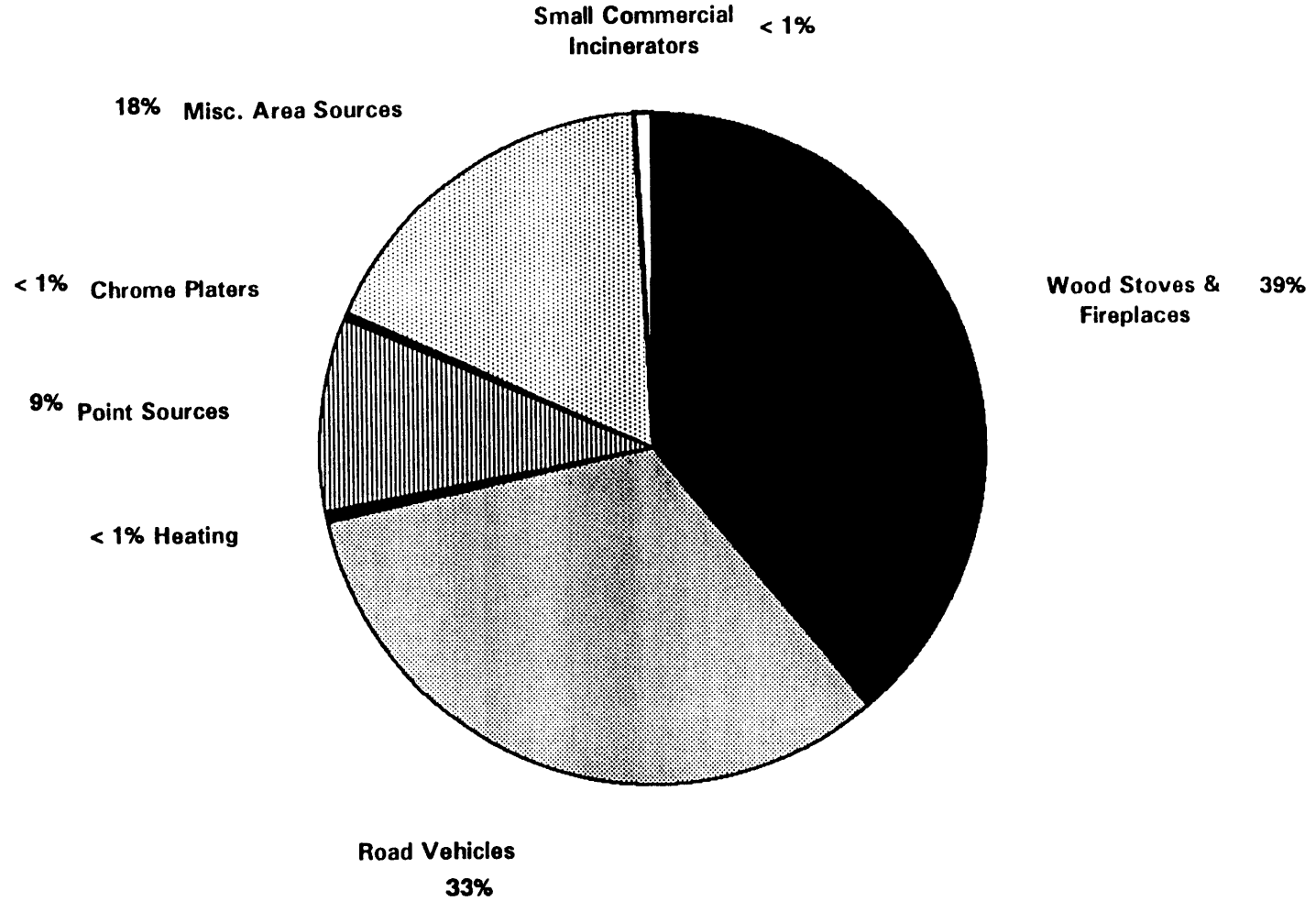


Figure IV-1. Sources of carcinogenic pollutant emissions in the 7-County Twin Cities Metropolitan Area.

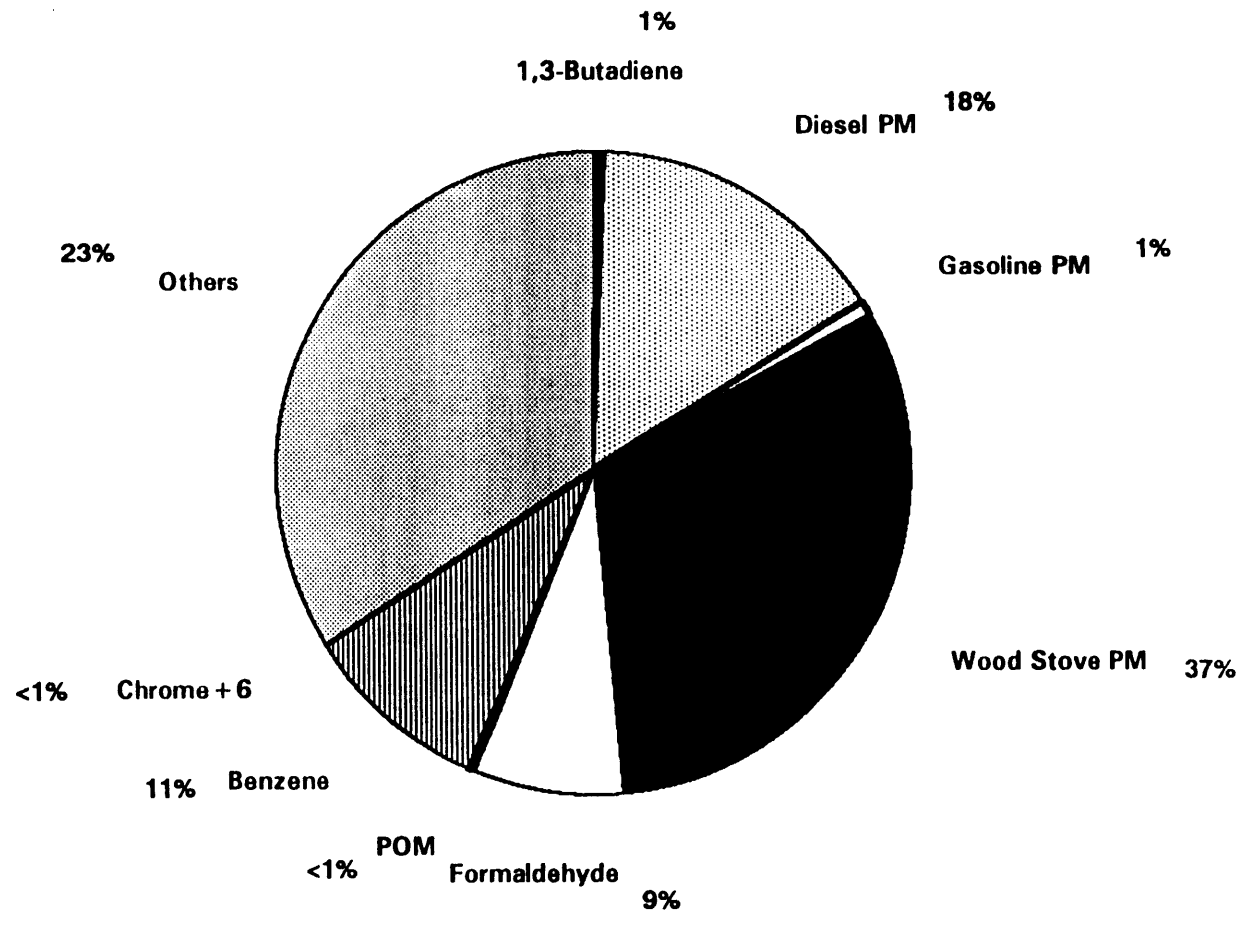


Figure IV-2. Emissions of carcinogenic pollutants in the 7-County Twin Cities Metropolitan Area.

V. AIR DISPERSION MODELING

1. GENERAL

Comments in this section apply in general to air dispersion modeling conducted for this study.

Methodology

The MPCA provided ViGYAN, a consultant, with meteorological data to conduct the air dispersion modeling for this study. Annual average concentrations were determined because this is the averaging period needed for cancer assessment.

Two dispersion models were used in this study - Industrial Source Complex-Long Term (ISCLT) for point sources, and Climatological Dispersion Model (CDM) for area sources. ISCLT is designed for use in evaluating complex industrial sources. However, ISCLT is not well suited to modeling widespread area sources. CDM, on the other hand, is not well equipped for handling complex industrial sources - its strength lies in treatment of area sources. Both models are recommended for use by EPA for regulatory purposes and are therefore reviewed and updated on a regular basis.

The emission points used in this study vary with the source type - details are discussed later in this section. The receptors in this study were defined as the centroids of the census tracts within the modeling domain for all source types. There were 366 census tracts in the source area and 284 in the receptor area.

The use of the census tract centroid as the receptor means that air pollutant concentrations nearby specific facilities were not calculated. This in turn means that the possible risk to individuals living quite near specific facilities was not calculated. Therefore, maximum individual risks are not addressed by this study.

Uncertainties

There are many uncertainties in the modeling portion of this study. ISCLT and CDM are both highly sensitive to assumptions.

The models can only accurately estimate concentrations if the input, i.e. the emissions inventory, is accurate. Dispersion factors are best described as probabilities as opposed to certainties. Meteorologic conditions can vary

widely, as can emissions. Modeling complexity increases if the terrain is complex such as in downtown areas. The effects of this complex terrain on the receptors were not taken into account in this study. The dispersion models have only been validated for a small number of scenarios, yet they are applied to a wide variety of conditions.

2. POINT SOURCES

Methodology

In modeling the point sources, ViGYAN reviewed the stack parameter file containing point source information within the study area and ascertained that the appropriate file format was available for ISCLT modeling. ISCLT was run from the 820 emission points developed in the inventory process to the 297 census tract centroids within the modeling domain.

If the NEDS data were available for a source from the inventory, the stack locational data from NEDS were used. This applied to both TRI and NEDS data used for that source. If a source were only listed in TRI, default stack parameters were added for modeling. Those were:

Height =	10 feet
Exit Velocity =	1 meter/second
Temperature =	ambient

The results of the point source modeling were further investigated to insure that there were no artificially high results due to overlap of source and receptor. ViGYAN reviewed the location of sources and receptors and determined that no significant interferences resulted.

Uncertainties

In some cases stack parameters were uncertain or missing. The TRI data base does not contain any stack data and many facilities were missing good location data. Where stack parameters were not available, conservative default values were used. Uncertain data for stack parameters and locations yield uncertain dispersion factors.

TRI Emissions are reported as annual quantities and do not indicate whether these quantities are released evenly throughout the year or sporadically in large amounts. NEDs emissions are calculated only on an annual basis. If peak emissions coincide with worst-case meteorological conditions, resultant concentrations could be worse than predicted by the model. Therefore, since ISCLT and CDM use annual totals based on averages, the models may either over or underestimate dispersion.

3. AREA AND MOBILE SOURCES

Methodology

The land usage data provided by the Metropolitan Council (as discussed in the Area Source Inventory section) were used to compute each census tract's fraction of its county's total acreage for five categories:

- Commercial acreage
- Industrial acreage
- Commercial and industrial acreage
- Total residential acreage
- Single-family residential acreage

These were summed to the nearest square kilometer (km).

A sixth category - population - was also used for apportionment of emissions.

For area sources, ViGYAN designed the modeling protocols for running CDM. It was necessary to model each apportionment scenario for each county. Therefore, CDM was then run 42 times - once for each of five landuse based categories, once for population, and for each of those within each county (six categories multiplied by seven counties).

Mobile sources were run like other area sources - using CDM. As noted in section IV., mobile sources were apportioned by population.

Area source emissions data were generally based on area wide estimates (refer to Section IV. and Appendix B.) Emissions were assumed to be evenly distributed over census tracts. However, In order to run properly, CDM requires that input files be on a regular (grid-like) basis. Therefore, the study are was divided into a 1 km square grid.

This effect of this division into a 1 km square grid varied. In areas were census tracts are small (less than 1 km square), emissions of multiple census tracts were combined where necessary - i.e. one emission point in these areas may represent more than one census tract. This occurred largely in inner city areas of Minneapolis and St. Paul. In areas where census tracts are large (greater than 1 km square) all the emissions for the census tract were assumed to be emitted from the 1 km square area around the centroid of the census tract - i.e. one emission point in these areas represents one census tract and no census tract had more than one emission point. This occurred in areas outside of the center city. Therefore, many 1 km squares in the grid had zero emissions assigned to them.

CDM then calculated the resultant ambient concentrations from area source emissions. Those results were calculated at the census tract centroids. The results reflected all modeled areas that had an impact on a particular centroid.

Uncertainties

As previously discussed, in CDM, 1 km square areas were used to provide more precise results. Using larger cells such as 2x2 km, would have yielded similar results. But, a smaller cell size such as 100x100 meters, would have yielded higher concentrations.

For area sources, the accuracy of apportioning county emission totals to census tracts by using either population or land-use class is unknown. This method of apportioning assumes that population or specific land-use classes can be used as surrogates to estimate the actual distribution of emissions.

Limitations

In many studies of this type, study results are viewed on a local as well as area wide basis - i.e. results are presented on a geographical basis across the study area. The method of assigning emissions from area sources to 1 km squares for modeling purposes in this case had the result of limiting such geographical analysis. This is discussed below.

Census tract size (area) varies significantly. For example, census tract 265.03, located in the northwest of the receptor area, is approximately 51 times larger than census tract 54 which is located in downtown Minneapolis. Further, population is not uniform across census tracts. Many of the geographically larger census tracts also have higher populations.

In large census tracts, emissions were assigned to a single 1 km square. If the census tract is one with a high population or a high proportion of a particular land use, those emissions may be quite large. Further, only one result was calculated for each tract. Generally, then, large census tracts were treated with less precision than small census tracts. If results are viewed on a geographical basis this lack of precision manifests itself by showing unrealistically high results at the centroids of large census tracts. However, these higher results are merely indicative of the size of the tract and the method apportionment of emissions over the tract. It is not indicative of a higher level of risk at a single point - the centroid of a census tract where the result was calculated. Therefore, careful interpretation of the results is required. Only total receptor area-wide results are reported here for this reason.

4. OUTPUT

Methodology

The output from both ISCLT and CDM were integrated into a risk screening data base. PIPQUIC cross multiplies emissions, unit risk factors, and dispersion factors to estimate total concentration, risk and excess incidence using the following formulas:

- Concentration of pollutant P from source S at census tract R =
  (Emission of pollutant P from source S) x (Dispersion factor from S to R)

- Total concentration of pollutant P at census tract R =
  Sum of (Concentration of P contributed by source S) for all S

The large number of emission points and modeling complexities, required that the number of emission points under consideration be reduced. This was done by first multiplying emissions by their respective unit risk factors for each pollutant for each stack. Then the results were ranked in order of size.

This resulted in a list of emission points ranked in order of importance with respect to carcinogenicity - the higher on the list, the more important. The top 200 points accounted for approximately 97% of the total weighted emissions. Therefore, modeling results for these top 200 points were stored and used in the remainder of the study. These 200 points represent emissions from 98 facilities.

Uncertainties

The reduction in the number of emission points from 820 to the top 200 added uncertainty to the results. While it was estimated that the top 200 stacks accounted for approximately 97% of the weighted emissions, this step might have led to a slight underestimation of concentrations and risk.

VI. RISK ASSESSMENT

Methodology

A quantitative risk assessment generally involves four steps:

1. Identifying a hazard.
2. Assessing the dose-response relationship of the chemical to relate the magnitude of the exposure to the likelihood that health effects will occur.
3. Determining the exposure of that chemical in the study area of interest.
4. Characterizing the risk from exposure.

A risk assessment may consider a wide variety of human health risks including cancer, birth defects, developmental effects, neurotoxicity, and other adverse health effects. The scope of this study was limited to an analysis of cancer effects.

The first step of the risk assessment developing the emissions inventory which characterized the type and quantity of air emissions in the study area. The second step, determining the dose-response relationship between the pollutants and carcinogenicity, was based solely on EPA-derived unit risk estimates.

The exposure assessment step was accomplished in this study by apportionment of the emissions and air dispersion modeling (see sections IV and V).

It should be reiterated that in the techniques used in air dispersion modeling affected the exposure assessment step. Specifically, the modeling was conducted in a manner that does **not** yield **maximum** individual risk - but rather area-wide risk data.

This report section represents the fourth step - characterizing the risk. In general the determination of risk estimates can be summarized as follows:

Risk due to exposure to pollutant P =
Concentration of pollutant P x Unit risk factor for pollutant P

In this study the risk was calculated as follows:

- Individual risk at census tract R =
  Sum of (Total concentration of pollutant P x Unit risk factor for pollutant P) for all P

- Estimated excess cancer incidence at census tract R =
  (Individual risk at R) x (Population of R)

- Estimated excess cancer incidence for entire study area =
  Sum of (Estimated excess cancer incidence at census tract R) for all R

Unit risk estimates used in the study are listed along with the list of pollutants in Table III-1.

The population of the receptor area is 1,227,584. This is a 1983 population estimate from the US EPA Graphical and Exposure Modeling System (GEMs).

Polycyclic Organic Matter (POM)

The unit risk estimate included in Table III-1 for polycyclic organic matter (POM) deserves some comment. The term POM is applied to a large group of organic compounds containing two or more aromatic rings. The treatment of POM in urban air toxics studies has varied widely. This study used two different approaches in assessing the cancer risk from POM.

A. Comparative Potency Factor Approach

For assessing the health impact from POM from residential wood combustion and from mobile source (gasoline and diesel) particulate emissions, the comparative potency factor approach was used. This method derives a cancer unit risk estimate for a complex substance or mixture by the use of available animal bioassay data. The unit risk estimate is extrapolated from human health risk data for a reference substance based on the ratio of short term bioassay results of the complex substance (such as diesel particulates) to the reference substance. The following formula is used:

$$\text{Estimated Human Risk of Untested Mixture} = \text{Estimated Human Risk of a Tested Carcinogen} \times \frac{\text{Bioassay Potency:Untested Mixture}}{\text{Bioassay Potency:Tested Carcinogen}}$$

Comparative potency factors used in this study were taken from Table III.3 of the EPA document "Analysis of Air Toxics Emissions, Exposures Cancer Risks and Controllability in Five Urban Areas, EPA-450/2-89-012a, July 1989. In the case of gasoline particulate, it was assumed that 75% of the fleet had catalytic converters and 25% did not.

B. B(a)P Surrogate Approach

For assessing the health impact of POM from all other source types, the B(a)P surrogate approach was used. This method inventoried all sources of POMs and applied the unit risk estimate for B(a)P to the total.

Uncertainties

This study used EPA-derived cancer unit risk estimates to estimate the upper bound of the cancer risk associated with the modeled air concentrations.

A unit risk estimate (URE) attempts to estimate upper bound risks due to relatively low chemical exposures, based on the results of animal experiments or human epidemiology studies in which the exposures were much higher. Because of the uncertainties in extrapolating from high to low exposure levels, and from animals to humans, the values may not be accurate predictors of actual cancer incidence in a human population. They are intended to estimate the maximum potential cancer risk, based on the information available.

EPA classifies chemicals based on the weight of evidence of carcinogenicity. Chemicals that are classified by EPA as A or B1 have evidence for carcinogenicity from human studies. Class B2 carcinogens are considered likely to be carcinogenic in humans, based on their effects in animals. Class C carcinogens are considered to be possibly carcinogenic in humans, based on their effects in animals.

In cases where the unit risk values are based on human studies (Class A carcinogens), the unit risk estimates are likely to be more accurate than when they are based on animal studies (Class B or C carcinogens).

This study treated all Class A, B, and C carcinogens the same. In other words, the weight of evidence was not factored into any determination of risk, so that probable and possible carcinogens were treated as known human carcinogens.

Another source of uncertainty is that the unit risk factors estimate cancer risk resulting from an annual average concentration estimate over a 70-year lifetime exposure. Thus, it was assumed that emission levels for each source type remain constant over a 70-year lifetime. People are unlikely to spend a 70-year period in one place and emissions do not remain constant over such a long period of time. It is unclear how this assumption affects the study results since movement throughout the study area, travel out of the study area, exposure to indoor air pollutants, and seasonal/diurnal variations in emissions are ignored. The estimated cancer risk is based solely on inhalation of ambient air. Acute and subchronic effects and cancer cases resulting from exposure routes other than air were not considered.

In assessing cancer risk within the study area, cancer effects were assumed to be additive. No synergistic or antagonistic effects were considered. In addition, atmospheric transformation or secondary formation of pollutants was not considered. There is some evidence that irradiating a mixture of pollutants representative of urban air increases the mutagenicity of the mixture. The study did not account for global background concentrations of pollutants such as carbon tetrachloride, nor did it consider exposure to chemicals other than those listed in Table III-1.

VII. RESULTS

1. GENERAL RESULTS

The results of a study of this type are **estimates of the potential for excess cancer incidence from air pollution in the receptor area.** As stated previously, the incidence estimates are upper-bound estimates and are not literal predictions of cancer risk. (In the remainder of this report, all references to "excess incidence", or "incidence" refer to this excess cancer incidence from air pollution.) These results can be expressed in many ways - three are presented here. First a total incidence is given - called "aggregate risk". Second, an average incidence over the receptor area is calculated - called "population risk" or "average risk". Third, the area wide individual lifetime risk is calculated - often abbreviated as "individual risk":

Aggregate Risk:

The results of this study reveal an estimated increase in total cancer incidence in the receptor area from the sources and pollutants studied of:

> **222 excess cancer cases** over 70 years over the total population of the receptor area.

Population Risk (or average risk):

The population risk is expressed as the average number of incidence divided by the population of the receptor area and divided by 70 years of assumed exposure. This number is:

$$\frac{\text{222 Excess Cancer Cases}}{\text{1.2 million population x 70 years}} = \textbf{2.26 Excess cancers/year/million}$$

Area Wide Individual Lifetime Risk (individual risk):

The area wide individual lifetime risk is calculated by taking the aggregate risk and dividing by the population in the receptor area.

$$\frac{\text{222 Excess Cancer Cases}}{\text{1.2 million population}} = \textbf{1.85 X 10-4 Excess cancer/person}$$

OR 18.5 excess cancers/100,000 population

This value is not a **maximum** individual risk. Maximum individual risks (such as the risk to an individual living next to a specific facility) were not calculated in this study.

It is important to repeat that the results from this study cannot be used to indicate a specific location of highest risk within the receptor area. Only overall results for the receptor area can be described. This is appropriate when one considers the input to the study and its limitations. However, considered as an overall area-wide average the data provide a good indicator of cancer risk from air pollution in the Twin Cities study area.

2. DETAILED RESULTS

Figures VII-1 - VII-7 show detailed results of the study. Figure VII-1 shows the breakdown of the total incidence in the receptor area by source type (point, area, vehicular, etc.). Figure VII-2 shows the breakdown of total incidence by pollutant. Table VII-1D in Appendix D includes the numeric data from which Figures VII-1 - VII-7 were derived.

Sources:

Overall **61%** of the excess incidence can be attributed to **road vehicles.** This includes contributions from gasoline and diesel particulate as well as formaldehyde, benzene and 1,3-butadiene. Refer to Figure VII-3 for a breakdown of road vehicle incidence by pollutant.

The next most important source type is **wood stoves/fireplaces** - contributing **17%** of the incidence. This consists of risk due to emissions of wood stove particulate, formaldehyde and arsenic. Refer to Figure VII-4 for a breakdown of wood stove incidence by pollutant.

Other important categories include:

Source Category	% of Excess Incidence
Chrome platers	10%
Heating	7%
Small Commercial Incinerators	3%
Point Sources	1%
Miscellaneous Area Sources	1%

Figures VII-6 shows the source contributions for non-mobile (stationary) sources alone.

Pollutants:

The pollutants contributing the most to excess cancer incidence are **diesel and gasoline particulate** - accounting for **27% and 15%** of the incidence, respectively. This is followed by **wood stove particulate** with **15%**. These results are consistent with the incidence by source type. Refer also to the discussion regarding these pollutants in the Emission Inventory, Results, section of this report.

Other pollutants of concern include:

Pollutant	% of Excess Incidence
1,3, Butadiene	12%
Hexavalent Chrome	11%
POM	10%
Formaldehyde	4%
Benzene	4%
Other	3%

1,3 Butadiene is emitted primarily by mobile sources.

Figure VII-5 shows a breakdown of hexavalent chrome emissions. The incidence due to hexavalent chrome emissions is due primarily to chrome plating. However, 7% is attributed to cooling towers.

Figure VII-7 shows the pollutant contributions for non-mobile (stationary) sources alone.

Point Sources:

Table VII-1A in Appendix A is a list of point sources and their associated contribution to total incidence.

Comparison to emissions inventory:

The figures and tables in this part of the report can be compared to the figures and tables in the emissions inventory section. Such a comparison gives an indication of the relative importance of mass of emissions versus toxicity of emissions. It shows that a risk estimate depends both on the amount and toxicity of emissions.

3. ANALYSIS AND DISCUSSION

The results of this study can be compared to similar studies to gain a better understanding of our area, to provide information for planning, and to indicate areas needing further study,

Comparison to EPA "5-City Study":

General

The average risk and individual risk estimates are useful numbers because they can be compared to other studies conducted with similar methodologies. EPA has compiled results from 5 other urban air toxics studies [Analysis of Air Toxics Emissions, Exposures, Cancer Risks and Controllability in Five Urban Areas- EPA-450/2-89-012a, July 1989], often referred to as the "5-City Study". In the 5-City Study the average incidence varies from 2 to 10 excess cancers per million per year with an average incidence of 6. The average individual risk from the 5-City Study varies from 1.5 x 10-4 to 7 x 10-4 with an average of 4 x 10-4.

When compared with the above numbers, the Twin Cities results fall within the range of previous studies, but on the low side (average incidence of 2.3 and individual risk of 1.85 x 10-4). This comparison is valuable because it indicates that the Twin Cities study procedures are generally valid - since the results are within the range of other studies. However, they also indicate that the Twin Cities area may have a lower excess cancer incidence from air pollution than other urban areas.

The general results of the 5-City Study are included here as Figures VII-8 and VII-9 for purposes of comparison.

In terms of source contributions, the major difference between the Twin Cities results and the results of the other urban area air toxics studies is the greater impact of wood stoves and fireplaces and the lesser impact of point sources. In the 5-City Study, 6% of incidence was due to woodsmoke. In the Twin Cities study, 17% can be attributed to woodsmoke.

Formaldehyde and Chrome

It is important to note that there are at least two major differences between the Twin Cities study and the 5-City Study noted above. Those are in the estimation of risk due to formaldehyde exposure and assumptions regarding hexavalent chrome emissions.

With respect to formaldehyde, the 5-City Study utilized ambient air data for formaldehyde exposure. Those data were location specific. No such data were available for the Twin Cities area.

Formaldehyde is a breakdown product from emissions of many hydrocarbons. This is referred to as secondary formaldehyde production. Therefore, it is highly likely that formaldehyde is present in the ambient air in amounts higher than that directly emitted as formaldehyde. In the 5-City Study, ambient formaldehyde values of 3 - 6.7 micrograms/cubic meter of air were used. Translating the total risk due to direct formaldehyde emissions in the Twin Cities study into an ambient concentration would result in a value of approximately 0.5 micrograms per cubic meter. This is clearly lower than any of the ambient numbers used in the 5-City study. Using a value of 3 micrograms/cubic meter would result in an 18% increase in total incidence.

Therefore, the formaldehyde risk in the Twin Cities study is not comparable to that from the 5-City Study. Further, it is likely that the formaldehyde risk in the Twin Cities study, and therefore the aggregate risk, is underestimated. However, without actual ambient air quality data for the area, no definitive statement can be made.

Emission factors used to estimate hexavalent chrome emissions in the studies composing the 5-City Study varied widely. As detailed in Appendix C, emissions of hexavalent chrome were generally assumed to be only 1% of total chrome emissions in the Twin Cities study. The difference between hexavalent chrome emissions estimates in this study versus the 5-City Study could result in significant differences in levels of incidence. This is particularly true for point sources since less data is available.

Point Sources

The 5-City Study results for point sources provide valuable data for understanding why the point source contribution to risk in the Twin Cities study is lower than that in the 5-City Study - 1% compared to 8%.

Refer to the list of point sources contributing to the 8% of the "other" risk in the 5-City Study (Figure VII-9, box in upper right hand corner). This list of point sources includes chemical manufacturing, petroleum refining, iron & steel, glass manufacturing, and refractory manufacturing.

The Twin Cities study area does include petroleum refining and glass manufacturing activities. However, those activities are conducted outside of the receptor area. Incidence results for those emissions are only calculated in the receptor area - which is quite distant from the emission

facilities in these cases. Therefore, activities which accounted for 1.7% of point source risk in other studies do exist in the area but were not fully addressed by this study. The information from the 5-City Study indicates that such sources can contribute to risk and are worthy of further study.

The study area includes very little chemical manufacturing or refractory activities. The receptor area does include some iron and steel activities.

The study did not address the maximum individual risk such as might be experienced by an individual living adjacent to a specific facility. This is an important issue for most point sources but is not addressed in this type of study.

One further note on point sources: the Twin Cities area may be considered unique in that there are major point sources in the receptor area that emit very large amounts of non-carcinogenic substances. Although not carcinogenic, air emissions of these substances are not without impacts. This suggests the need for developing an urban area source study methodology that considers non carcinogens.

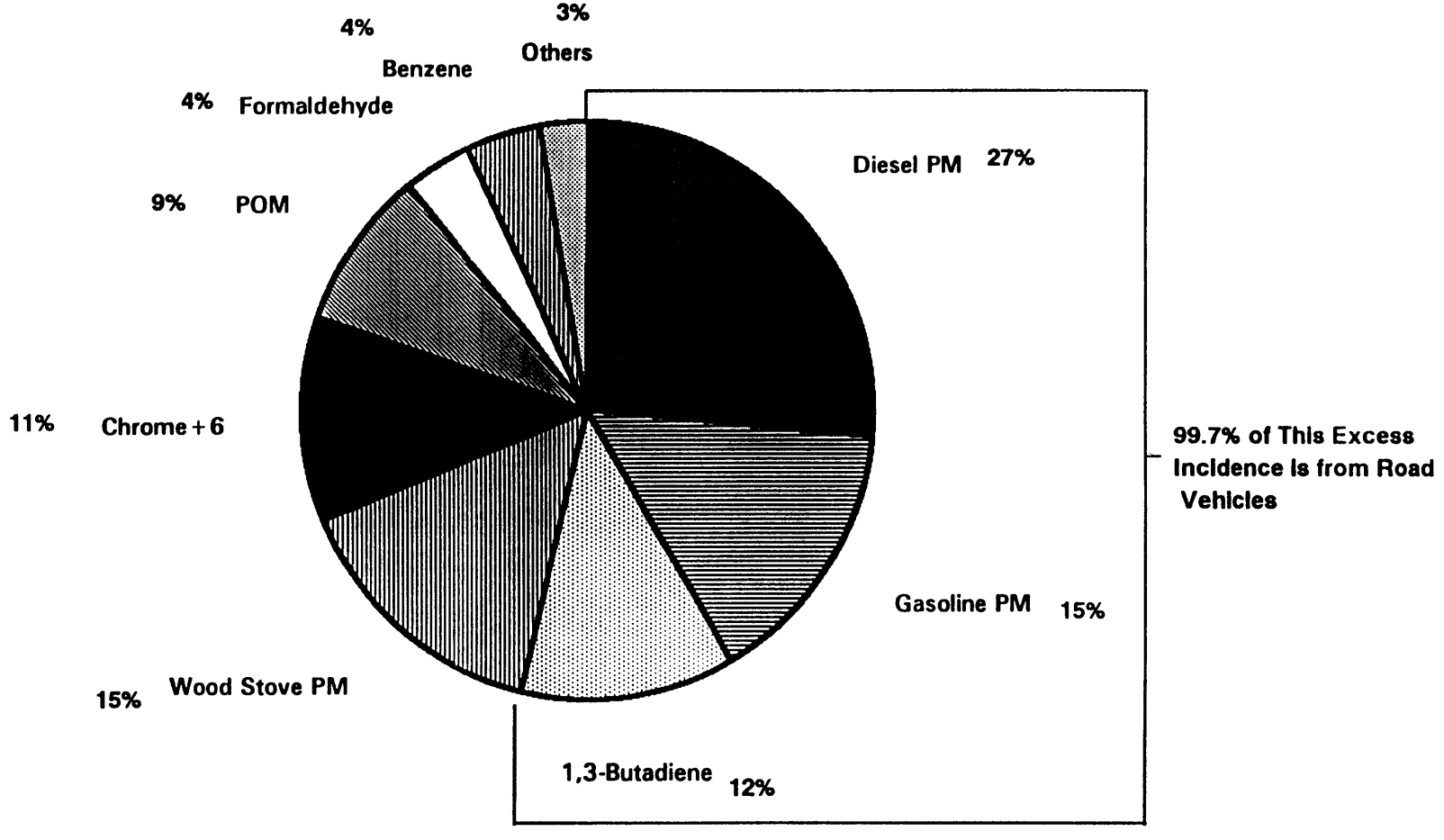
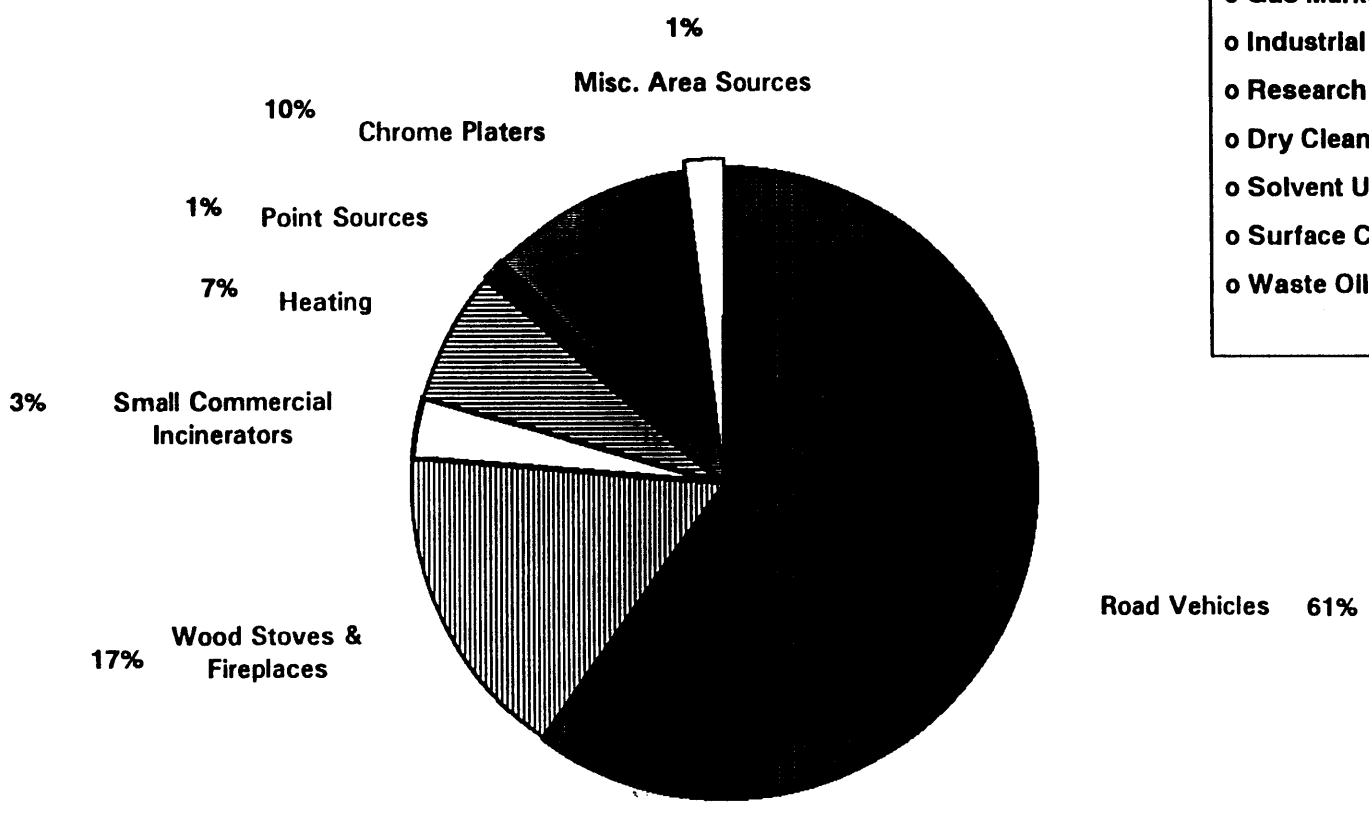


Figure VII-2. Estimated excess cancer incidence by pollutant.

Total Estimated Excess 70 Year Cancer Incidence = 222

= 2.26 excess cancer cases/year/million population in receptor area



Misc. Area Sources **Includes:**

o Comfort Cooling Towers	37%
o Degreasing	26%
o Small Hospitals	16%
o Gas Marketing	6%
o Industrial Cooling Towers	6%
o Research Labs	5%
o Dry Cleaners	1%
o Solvent Usage	1%
o Surface Coating	1%
o Waste Oil Burning	1%

Figure VII-1. Estimated excess cancer incidence by source category.

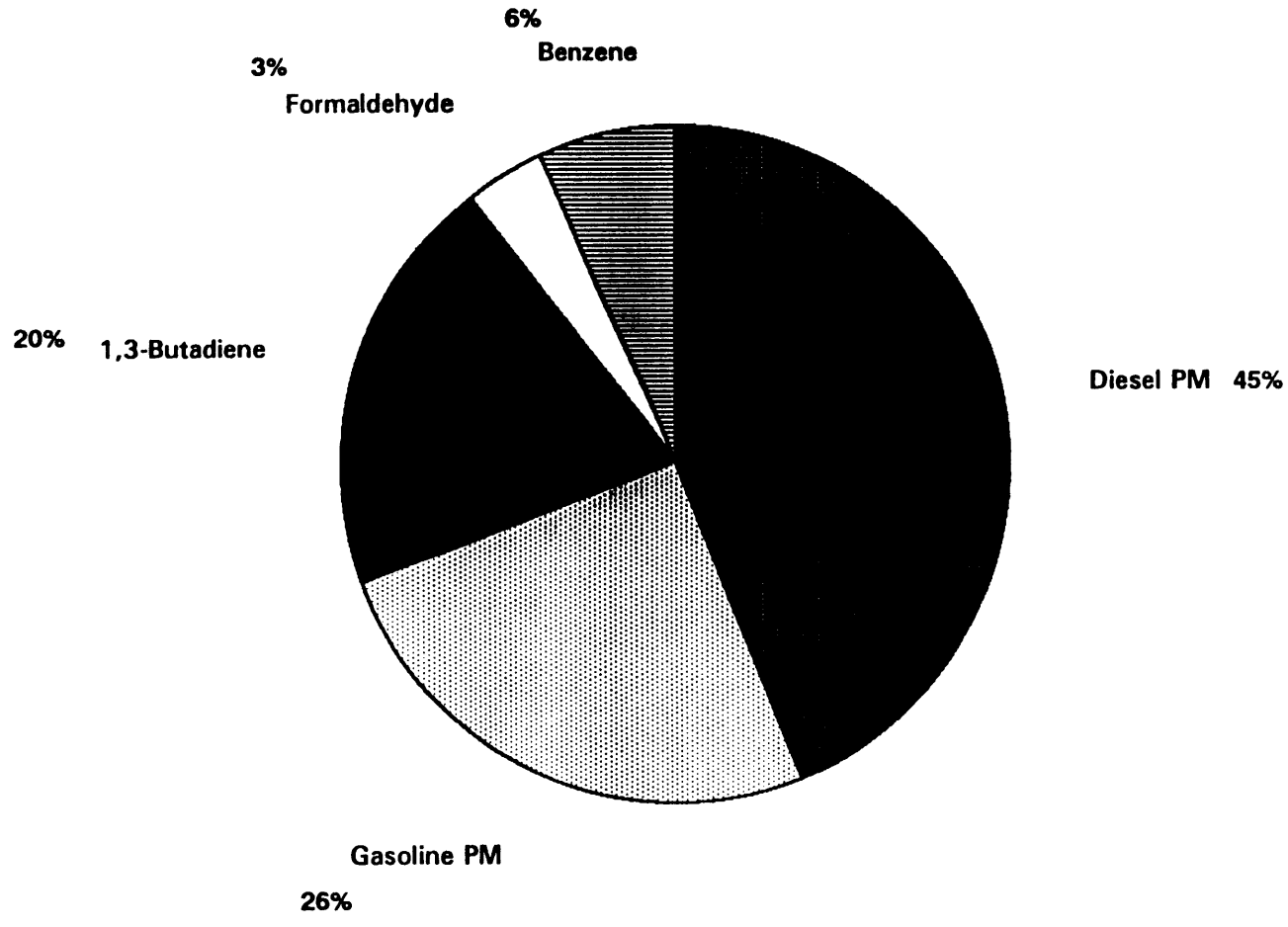


Figure VII-3. Estimated excess cancer incidence from Road Vehicles by pollutant.

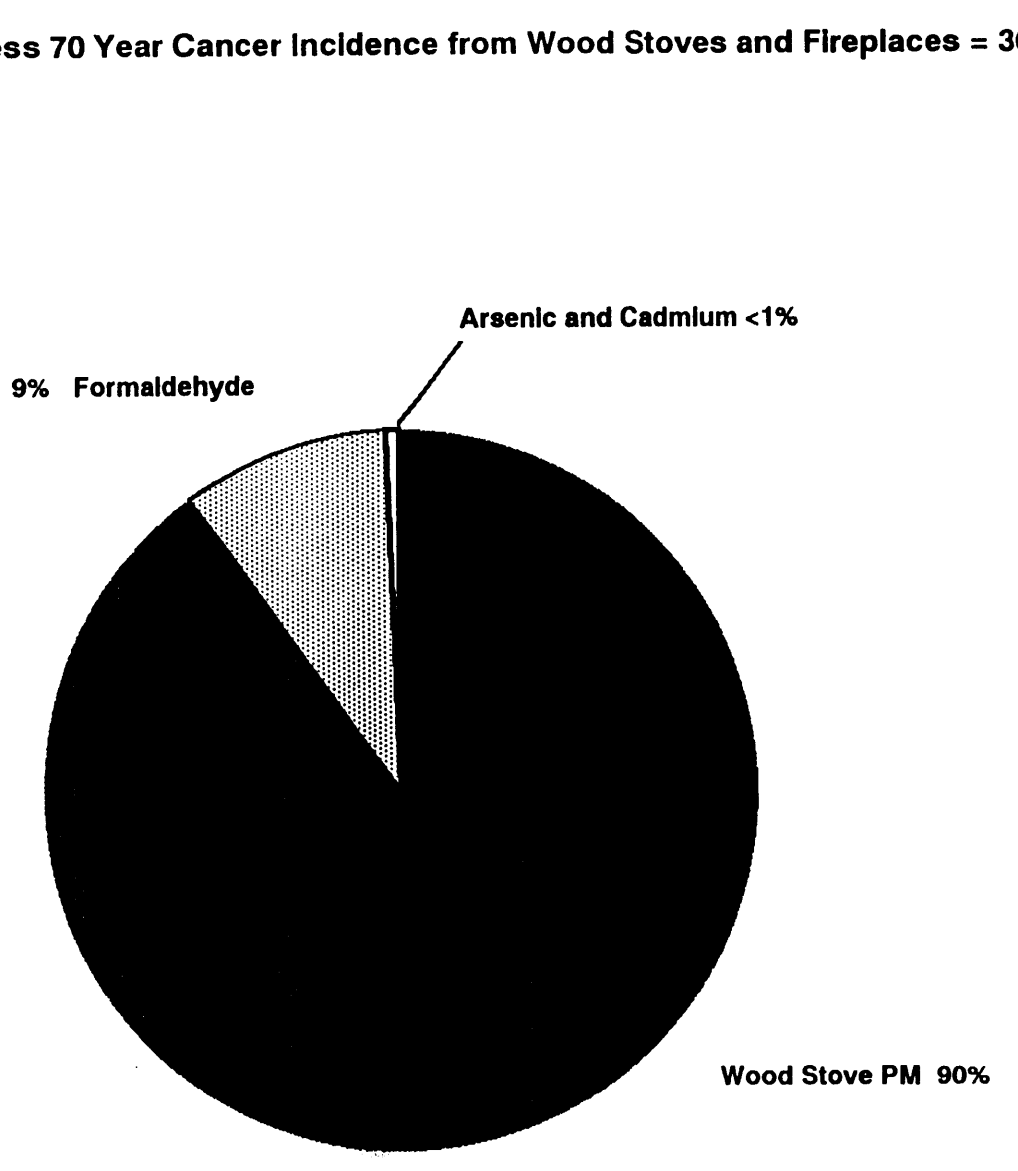


Figure VII-4. Estimated excess cancer incidence from Wood Stoves and Fireplaces by pollutant.

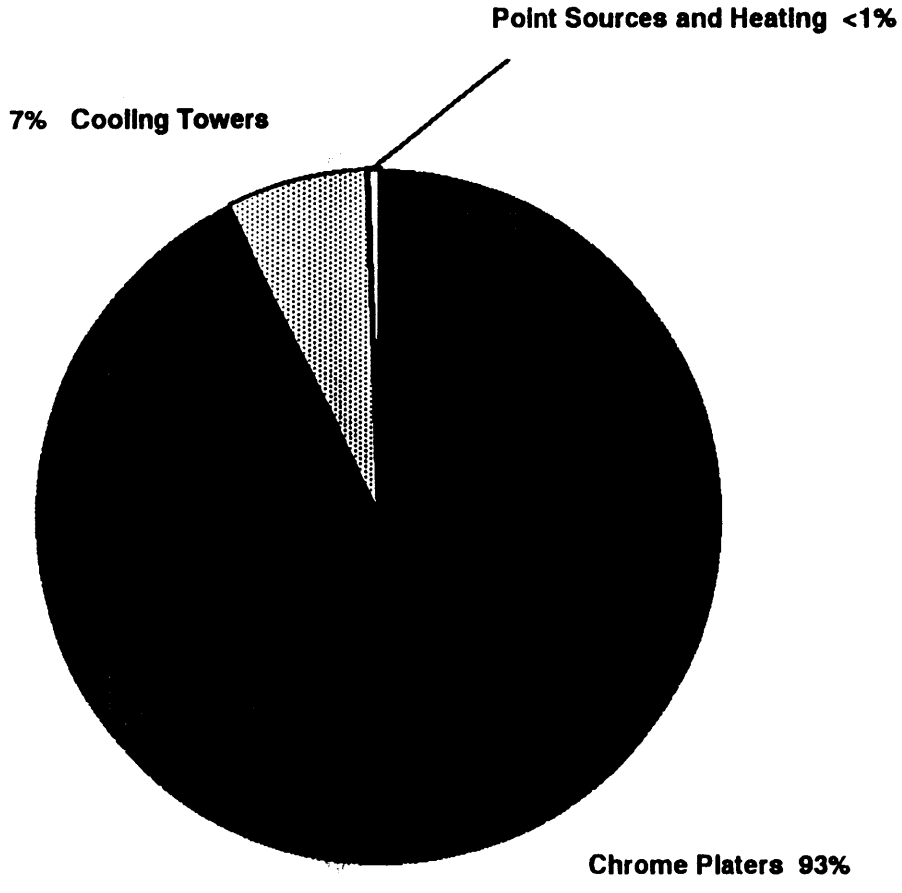


Figure VII-5. Estimated excess cancer incidence from Chrome+6 by source category.

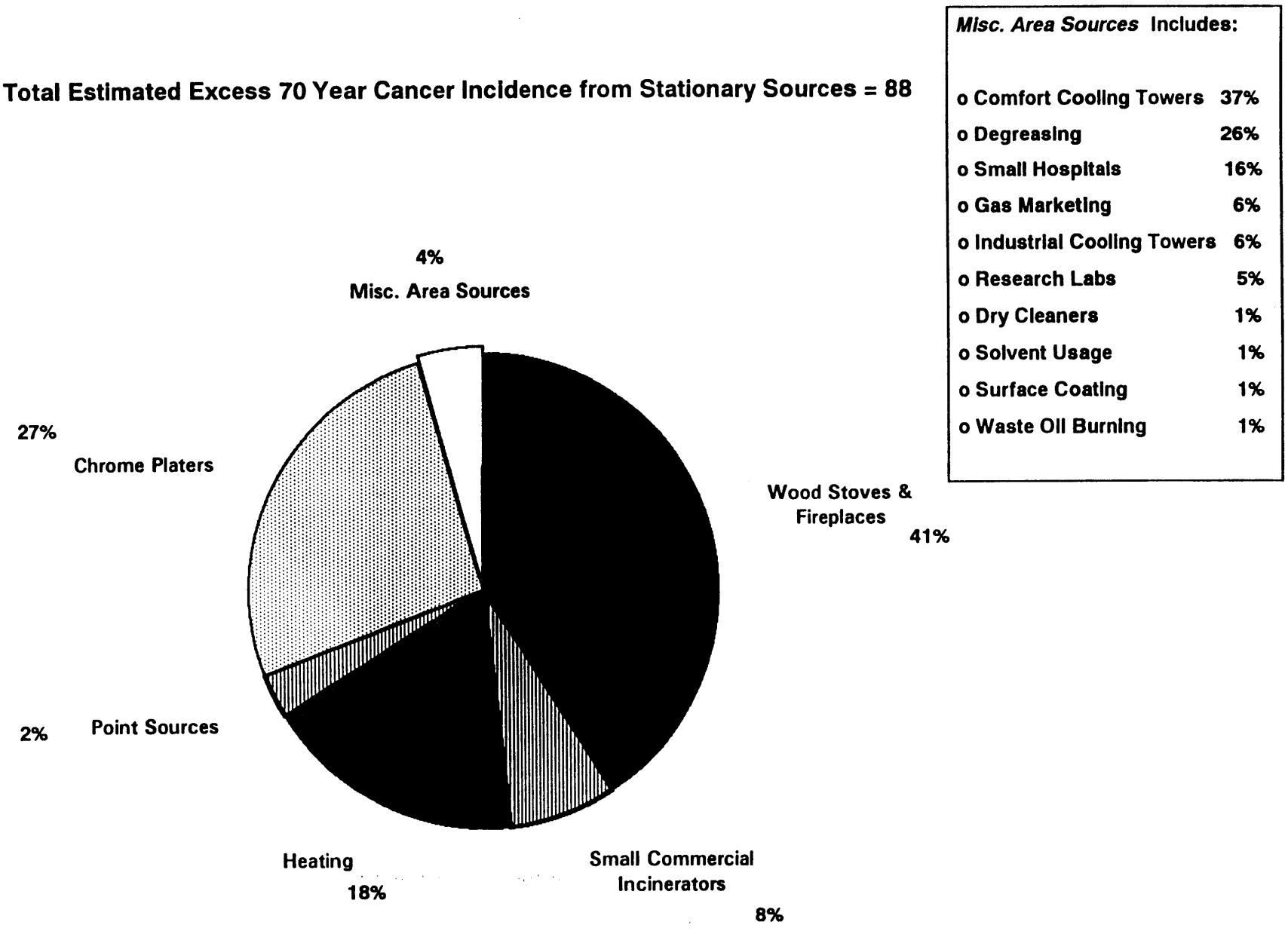


Figure VII-6. Estimated excess cancer incidence from stationary sources, by source category.

Total Estimated Excess 70 Year Cancer Incidence from Stationary Sources = 88

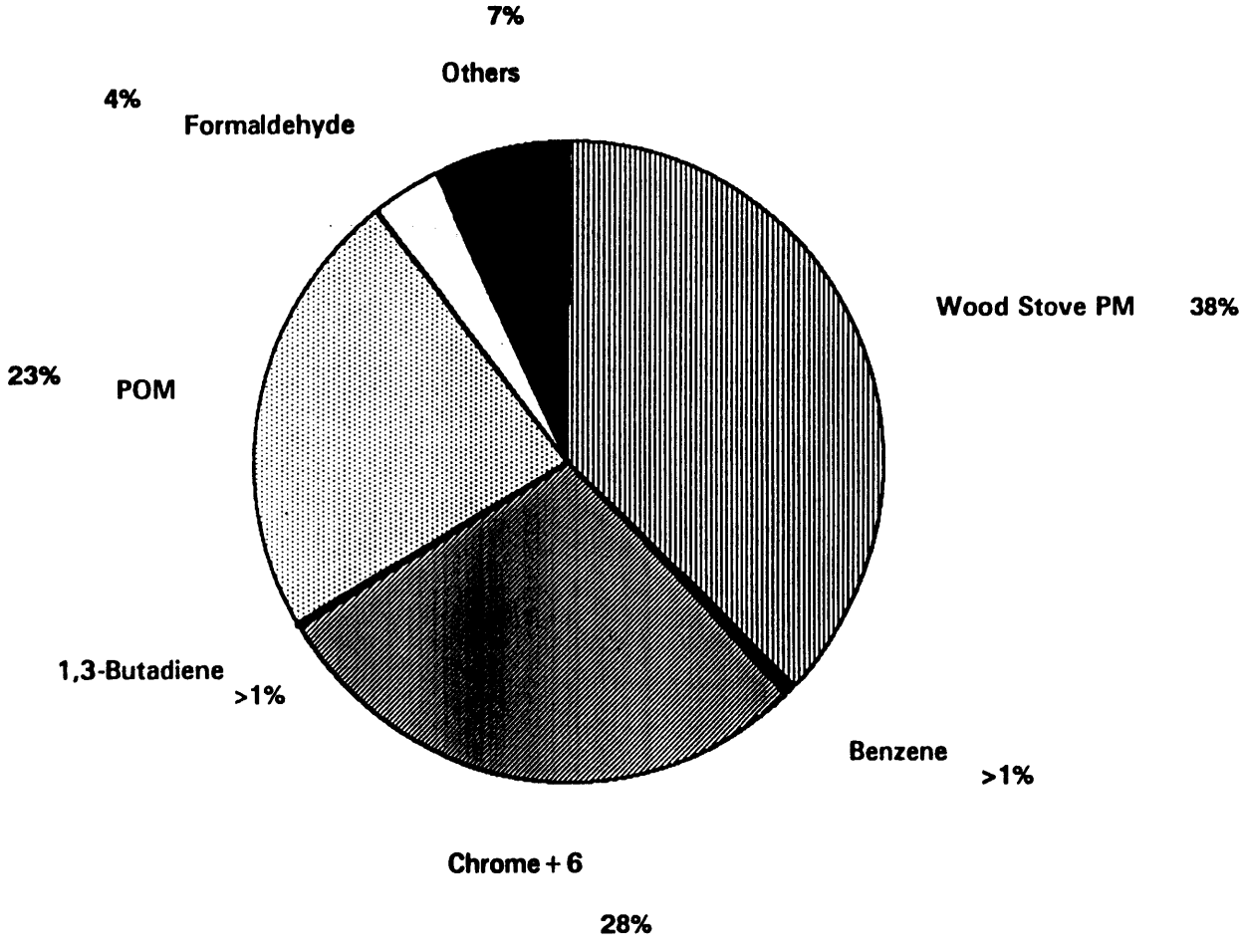
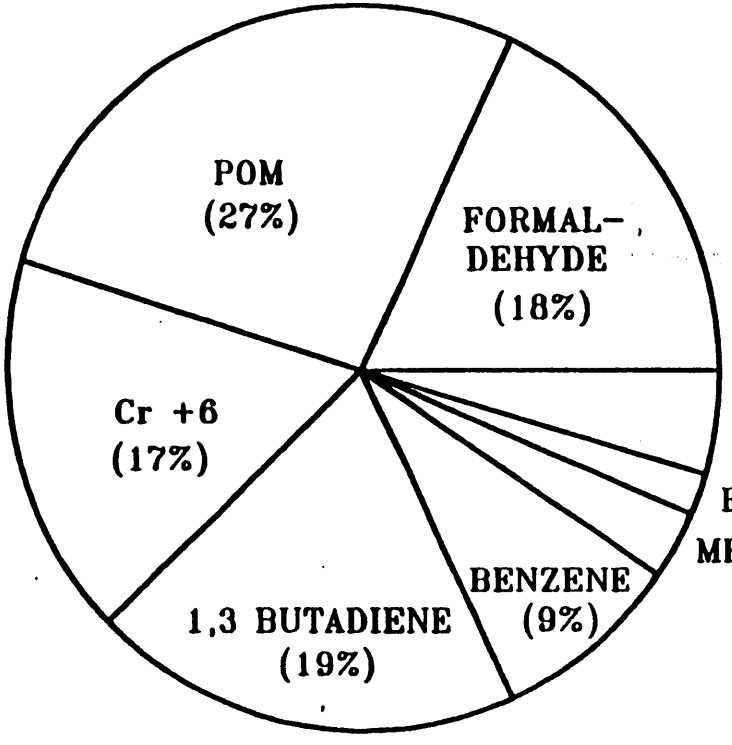


Figure VII-7. Estimated excess cancer incidence from stationary sources, by pollutant.

POLLUTANTS CONTRIBUTING TO FIVE CITY AVERAGE AGGREGATE CANCER INCIDENCE



OTHER (See box)

ETHYLENE OXIDE (2%)

METHYLENE CHLORIDE (3%)

OTHER (5%)

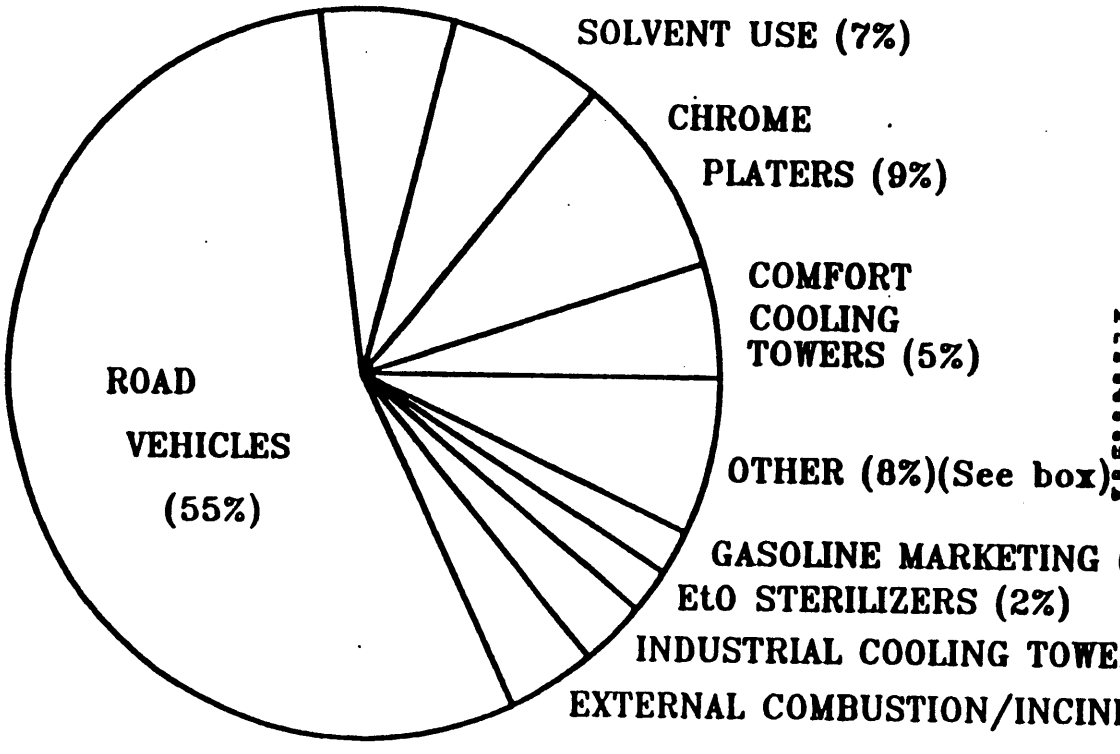
ARSENIC (1.2%)
EDC (0.9%)
GASOLINE VAPORS (0.8%)
CARBON TET (0.5%)
PERC (0.4%)
CHLOROFORM (0.2%)
TRICHLOROETHYLENE (0.2%)
CADMIUM (0.2%)
ASBESTOS (0.2%)
BERYLLIUM (0.1%)
VINYL CHLORIDE (<0.1%)

Note: No incidence values in this figure should be considered to represent absolute predictions of actual cancer occurrence. They should be used in a relative sense only for broad screening activities and to provide more focused program direction. The dose-response relationships and exposure assumptions are quite conservative. Errors due to missing pollutants (either directly emitted or secondarily formed), uncharacterized sources, and the lack of any mechanism to simulate synergism or antagonism among pollutants may potentially offset this conservative bias, but to an unknown extent.

AVERAGE FIVE CITY INCIDENCE = 5.8 CASES/YR/MILLION POPULATION

Figure VII-8. Results from EPA 5-City Study - Incidence by Pollutant.

SOURCES CONTRIBUTING TO FIVE CITY AVERAGE AGGREGATE CANCER INCIDENCE



OTHER (8%)

- CHEMICAL MFG (1.3%)
- REFINING (1%)
- IRON & STEEL (0.7%)
- GLASS MFG (0.7%)
- REFRACTORY MFG (0.6%)
- POTWs (0.6%)
- NON FERROUS METAL (0.2%)
- OTHER (3.1%)

Note: No incidence values in this figure should be considered to represent absolute predictions of actual cancer occurrence. They should be used in a relative sense only for broad screening activities and to provide more focused program direction. The dose—response relationships and exposure assumptions are quite conservative. Errors due to missing pollutants (either directly emitted or secondarily formed), uncharacterized sources, and the lack of any mechanism to simulate synergism or antagonism among pollutants may potentially offset this conservative bias, but to an unknown extent.

AVERAGE FIVE CITY INCIDENCE = 5.8 CASES/YR/MILLION POPULATION

Figure VII-9. Results from EPA 5-City Study - Incidence by Source Category.

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List of Acronyms

B(a)P	Benzo(a)pyrene
CBEDs	Block Enumeration Districts
CDM	Climatological Dispersion Model
CO	Carbon Monoxide
EPA, USEPA	Environmental Protection Agency
GEMs	US EPA Graphical and Exposure Modeling System
HERC	Hennepin Energy Resource Corporation
ISCLT	Industrial Source Complex-Long Term
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
NEDS	National Emissions Data System
NOx	Oxides of Nitrogen
PAHCs	Polycyclic Aromatic Hydrocarbons
PIPQUIC	Program Integration Project Queries Using Interactive Commands
PM10	Particulate Matter Less than or Equal to 10 Microns
POM	Polycyclic Organic Matter
SARA	Superfund Amendments and Reauthorization Act
SCC	Source Classification Code
SIC	Standard Industrial Classification
SOx	Oxides of Sulfur
TRI	Toxic Release Inventory
TSP	Total Suspended Particulates
UREs	Unit Risk Estimates
VMT	Vehicle Mile Traveled
VOCs	Volatile Organic Compounds

APPENDIX A

POINT SOURCE EMISSIONS INVENTORY AND RISK RESULTS

Table IV-IA	Point Source Inventory Results
Table VII-1A	Point Source Excess Incidence Results

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Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	FORMALDEHYDE	METHYLENE CHLORIDE	TRICHLORO ETHYLENE	BENZENE	PERCHLORO ETHYLENE	STYRENE	ETHYLENE DIBROMIDE	1,3-BUTADIENE
ASHLAND ST PAUL	262.378	0	0	14.0615	0	0.1633	0	5.89676
KOCH PINE BEND R	49.8957	0	1.49687	127.869	0	7.40847	0.002268	0
UNISYS SHEPARD R	0	124.494	51.4887	0	0	0	0	0
WOLKERSTORFER	0.006731	20.246	59.8748	0.00337	0	0	0.214642	0
SUPERIOR PLATING	0.010832	0	48.172	0.00542	0	0	0	0
UPSHER-SMITH LAB	0	42.6381	0	0	0	0	0	0
FMC NAVAL INDUST	0.037104	2.72884	37.195	0.01611	0	0.00863	2.47664	0
CONTROL DATA PC	0	37.7393	0	0	0	0	0	0
HITCHCOCK INDUST	0.028302	0	0	0.14123	36.1925	0	0	0
BUCKBEE-MEARS ST	0.006427	25.5829	0	0.00295	0	0	0.396262	0
ELECTRIC MACHINE	0.006606	0.055339	0	0.00313	22.7933	0	0.041277	0
SUPER RADIATOR C	0	0	0	0	22.1355	0	0	0
3M CHEMOLITE	0.544316	13.5943	0	0.50803	0	0	0	0
HONEYWELL DEFEN	0	0.033203	19.55	0	0	0.00925	0.024766	0
ECOWATER SYSTEM	0	13.8066	0	0	0	4.80132	0	0
MINN VALLEY ENGI	0	17.6903	0	0	0	0	0	0
AMOCO ROSEVILLE	0	0	0	16.7195	0	0.87136	0	0
ADC TELECOMMUNI	0	17.1233	0	0	0	0	0	0
PIONEER METAL FI	0	0	16.2791	0	0	0	0	0
ELECTROSTATIC FI	0.006806	15.6892	0	0.01225	0	0	0.148598	0
ANDERSEN	0.0005	10.8863	0	3.59247	0	0	0.180547	0
EATON HYDRAULICS	0	14.5151	0	0	0	0	0	0
WILLIAMS ST PAUL	0	0	0	12.9257	0	0.66661	0	0
3M MAIN PLANT	12.8141	0	0	0.02028	0	0	0	0
HONEYWELL MIL 79	0.008685	0	12.7007	0.00366	0	0	0	0
LINDBERG HEAT TR	0	0	12.7007	0	0	0	0	0
NORTH STAR STEEL	0.103279	0	0	0.05164	0	11.3505	0	0
KOCH FUELS	0	0	0	11.6365	0	0.60413	0	0
FREMONT INDUSTRI	0	10.8863	0	0	0	0	0	0
HONEYWELL MINNE	0	10.5235	0	0	0	0	0	0
CONTROL DATA	0	10.4327	0	0	0	0	0	0
MOBIL ST PAUL TE	0.001	0	0	9.69304	0	0.32079	0	0
HONEYWELL MIL 80	0.005242	0	9.84306	0.00262	0	0	0	0
GENERAL FOAM MIN	0	9.52554	0	0	0	0	0	0
MED-TEK	0	0	9.28967	0	0	0	0	0
FEDERAL-HOFFMAN	0.079475	6.6452	0	0.0423	0	0	2.07212	0
NICO PRODUCTS	0	0	7.25755	0	0	0	0	0
UNOCAL MARKETIN	0	0	0	6.64276	0	0.33374	0	0
ANCHOR HOCKING P	0	0	0	0	0	6.4946	0	0
JOYNERS SILVER + E	0	0	6.15395	0	0	0	0	0
PRECISION PLATNG	0	0	6.01016	0	0	0	0	0
UNISYS INFORMN S	0.003048	0.665492	3.42323	0.16384	1.20113	0	0	0
AMER NATL CAN 20	0.001	3.09897	0	0.0005	0	0	2.31153	0
ONAN MFG FACIL	0.047403	4.30917	0	0.31534	0	0.00464	0.016511	0.29413
NORTHWEST AIRLIN	2.92458	0	0	0.35777	0	0.06998	0	0.322997
PROFESSNL PLATNG	0	0	4.23387	0	0	0	0	0
ERICKSON PETROLE	0	0	0	3.93841	0	0.20545	0	0
INTERPLASTIC 554	0	0	0	0	0	3.85331	0	0
FLOUR CITY ARCHI	2.56303	0	0	1.27749	0	0	0	0
BYSTROM BROTHER	0	0	3.7195	0	0	0	0	0
MCLAUGHLIN 554 G	0	3.57072	0	0	0	0	0	0
CONTINENTAL CAN	0	2.9255	0	0.19079	0	0	0	0
PROSPECT FOUNDR	0.059508	0	0	2.94044	0	0	0	0
WALDORF	0.375314	1.44988	0	0.0076	0	0	1.08147	0
ME INTERNATIONAL	0.061487	0	0	2.68574	0	0	0	0
METRO WASTE MET	0.035352	0	0	2.21458	0	0	0	0
AMERICAN LINEN S	0.905684	0	0	0.45284	0	0	0	0
U.MINN HOSPITAL	0	0	0	0	0	0	0	0
PDI	0	1.20203	0	0	0	0	0	0

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	FORMALDEHYDE	METHYLENE CHLORIDE	TRICHLORO ETHYLENE	BENZENE	PERCHLORO ETHYLENE	STYRENE	ETHYLENE DIBROMIDE	1,3- BUTADIEN
PLATING INC	0.125563	0	0	0.48054	0	0.2048	0	0.04150
ANCHOR GLASS CO	0.481601	0	0	0.623	0	0	0	
FOTO MARK	0.003314	1.03284	0	0.06899	0	0	0	
NORTHERN MALLEA	0.022043	0	0	1.05495	0	0	0	
SPARTAN MFG	0	0	0	0	0	1.02331	0	
MPLS ENERGY MAIN	1.00222	0	0	0.01622	0	0	0	0.00305
MAXWELL COMM S	0.959541	0	0	0.00407	0	0	0	
TOTAL ASPHALT CO	0.56778	0	0	0.28389	0	0	0	
SMITH FOUNDRY IR	0.017404	0	0	0.84385	0	0	0	
ABBOTT/NORTHWES	0.046832	0	0	0.03263	0	0	0	
STONE CONTAINER	0.750202	0	0	0.0015	0	0	0	
NATIONAL FOUNDR	0.013105	0	0	0.64961	0	0	0	
CS MCCROSSAN CO	0.418888	0	0	0.20944	0	0	0	
3M CHEMOLITE INC	0.003201	0	0	0.57704	0.022453	0	0	
MCNAMARA CONTR	0.395997	0	0	0.198	0	0	0	
VETERANS ADMIN	0	0	0	0	0	0	0	
FAIRVIEW SOUTHDA	0	0	0	0	0	0	0	
SCOTT-ATWATER F	0.011181	0	0	0.55428	0	0	0	
FORD MOTOR ASSE	0.133358	0	0	0.38447	0	0	0	
PIER FOUNDRY + PA	0.010211	0	0	0.50619	0	0	0	
METRO MED CTR	0.170092	0	0	0.0542	0	0	0	
RIVERSIDE MEDCTR	0	0	0	0	0	0	0	
TOWER ASPHALT	0.299434	0	0	0.14972	0	0	0	
INTERPLASTIC 551	0	0	0	0	0	0.4536	0	
UNIVERSAL PLASTI	0	0	0	0	0	0.4536	0	
ACROMETAL PROGR	0.01776	0	0	0.4085	0	0	0	
GOPHER SMELTING	0.011732	0	0	0.00616	0	0	0	
N ST PWR KING PL	0	0	0	0.05365	0	0	0	
WM MUELLER + SON	0.244392	0	0	0.11582	0	0	0	
CENTRAL CASTINGS	0.007239	0	0	0.35899	0	0	0	
ATWATER GROUP B	0.35749	0	0	0.00554	0	0	0	
ASSOCIATED ASPH	0.225227	0	0	0.11261	0	0	0	
METRO WASTE SEN	0.017385	0	0	0.22681	0	0	0	
ST PAUL RAMSEY M	0.029421	0	0	0.30724	0	0	0	0.0010
TAPEMARK	0	0	0	0	0.340198	0	0	
TA SCHIFSKY + SON	0.207007	0	0	0.1035	0	0	0	
3M MAPLEWOOD CT	0.307561	0	0	0.00975	0	0	0	
HARDRIVES CEDAR	0.169536	0	0	0.08165	0	0	0	
HENN COUNTY MED	0	0	0	0	0	0	0	
MIDW ASPHALT NE	0.175108	0	0	0.08843	0	0	0	
MPLS ASPHALT PLT	0.169584	0	0	0.08479	0	0	0	
MIDW ASPHALT EDE	0.166131	0	0	0.08645	0	0	0	
ACME FOUNDRY	0.004826	0	0	0.23925	0	0	0	
BUREAU OF ENGRAV	0	0	0.226799	0	0	0	0	
N ST PWR RIVSIDE	0.007201	0	0	0.20464	0	0	0	
BURY + CARLSON PE	0.13822	0	0	0.06911	0	0	0	
PINE BEND PAVING	0.13015	0	0	0.06508	0	0	0	
ECONOMICS LABOR	0.125973	0	0	0.06299	0	0	0	
COLLEGE OF ST CA	0.181449	0	0	0.00569	0	0	0	
BITUM RDWY BARB	0.111984	0	0	0.05599	0	0	0	
HAMLINE UNIVERSI	0.096922	0	0	0.04039	0	0	0	
CONSOL. CONTNR 9	0.001	0.044271	0	0.0005	0	0	0.033022	
BRYAN ROCK 29 PR	0	0	0	0	0	0	0	
STROH BREWERY	0.080332	0	0	0.04287	0	0	0	
UNISYS DEFENSE S	0.080232	0	0	0.04012	0	0	0	
ST P ASPHALT PLT	0.067588	0	0	0.03379	0	0	0	
COOK PAINT + VARN	0	0	0	0	0	0.1134	0	
VELTEX CHEMICAL	0.113399	0	0	0	0	0	0	
U.MINN MPLS CAMP	0.084126	0	0	0.0218	0	0	0	

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	FORMALDEHYDE	METHYLENE CHLORIDE	TRICHLORO ETHYLENE	BENZENE	PERCHLORO ETHYLENE	STYRENE	ETHYLENE DIBROMIDE	1,3-BUTADIENE
CERTAINTEED SHEL	0.075598	0	0	0.03106	0	0	0	0
BRYAN ROCK 06 PR	0	0	0	0	0	0	0	0
CONSOL. CONTNR 4	0.001	0.011068	0	0.0005	0	0	0.008255	0
N ST PWR INVER H	0.059757	0	0	0.00772	0	0.00155	0	0.007166
GENERAL MILLS PU	0.062797	0	0	0.02895	0	0	0	0
BONGARDS CREAME	0.060817	0	0	0.024	0	0	0	0
COMML ASPHALT M	0.037119	0	0	0.01856	0	0	0	0
WILLIAMS ROSEMNT	0	0	0	0.07603	0	0	0	0
DISTRICT ENERGY	0.05065	0	0	0.00414	0	0	0	0
NORTHERN NATURA	0.06244	0	0	0.00848	0	0	0	0
N ST PWR HIGH BR	0.013412	0	0	0.00671	0	0	0	0
N ST PWR BLUE LK	0.039946	0	0	0.00516	0	0.00104	0	0.00479
FLEISCHMANN-KURT	0.040669	0	0	0.02033	0	0	0	0
NORTHERN ASPHAL	0.033668	0	0	0.01683	0	0	0	0
TENNANT	0.012925	0.022136	0	0.00587	0	0	0.016511	0
N ST PWR BLK DOG	0.012447	0	0	0.00572	0	0	0	0
COMML ASPHALT P	0.021925	0	0	0.01096	0	0	0	0
COMML ASPHALT B	0.020579	0	0	0.01029	0	0	0	0
JL SHIELY LARSON	0	0	0	0	0	0	0	0
JACOB SCHMIDT BR	0.029161	0	0	0.01458	0	0	0	0
SPECTRO ALLOYS	0.026541	0	0	0.01327	0	0	0	0
VAN HOVEN	0.033183	0	0	0.00435	0	0	0	0
GLOBE BUILDING M	0.03455	0	0	0.00154	0	0	0	0
JL SHIELY SHAKOP	0.002308	0	0	0.00115	0	0	0	0
DEPT ARMY TCAAP	0.021185	0	0	0.01059	0	0	0	0
HONEYWELL RESIDE	0.018215	0	0	0.00911	0	0	0	0
GAF BUILDING MAT	0.016821	0	0	0.00882	0	0	0	0
LEEF BROTHERS	0.016464	0	0	0.00823	0	0	0	0
COMML ASPHALT E	0.011735	0	0	0.00115	0	0	0	0
AMER NATL CAN 54	0.015578	0	0	0.00779	0	0	0	0
COOP POWER ASSO	0.013965	0	0	0.00181	0	0.0004	0	0.001675
NL CHEMICALS SPE	0.016556	0	0	0.00468	0	0	0	0
U.MINN ST PAUL C	0.010669	0	0	0.00533	0	0	0	0
HONEYMEAD PRODU	0.003048	0	0	0.01629	0	0	0	0
BITUM RDWY CEDA	0.00827	0	0	0.00414	0	0	0	0
RICHARDS ASPHALT	0.001825	0	0	0.0001	0	0	0	0
PILLSBURY RED RO	0	0	0	0	0	0	0	0
PILLSBURY MPLS A	0.010364	0	0	0.00518	0	0	0	0
OWENS-CORNING FI	0.009326	0	0	0.00392	0	0	0	0
CARGILL DOMESTIC	0.012703	0	0	0.0005	0	0	0	0
HENNEPIN ENERGY	0	0	0	0	0	0	0	0
PACKER RIVER TER	0.0002	0	0	0.0001	0	0	0	0
LAND O LAKES AGR	0.008695	0	0	0	0	0	0	0
PURINA MILLS BP	0.005673	0	0	0.0026	0	0	0	0
GROSS-GIVEN MFG	0.005385	0	0	0.00269	0	0	0	0
U.MINN MPLS SE S	0	0	0	0	0	0	0	0
RAHR MALTING SHA	0.004039	0	0	0.00202	0	0	0	0
AMER NATL CAN 21	0.00327	0	0	0.00164	0	0	0	0
ASHBACH CONSTRU	0.0009	0	0	0.0005	0	0	0	0
MEDALLION KITCHE	0.0025	0	0	0.00125	0	0	0	0
CON AGRA FLOUR M	0.002235	0	0	0.00112	0	0	0	0
VAN DALE	0.002349	0	0	0.0009	0	0	0	0
KOCH REFINING SU	0	0	0	0	0	0	0	0
UNIMIN MINNESOTA	0.001923	0	0	0.001	0	0	0	0
CONCORDIA COLLEG	0.001727	0	0	0.0009	0	0	0	0
HM SMYTH	0.001346	0	0	0.0007	0	0	0	0
MPLS ENERGY N RI	0.0008	0	0	0.0004	0	0	0	0
RED ROCK OF MINN	0	0	0	0	0	0	0	0
AMER NATL CAN 01	0.0004	0	0	0.0002	0	0	0	0

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	FORMAL DEHYDE	METHYLENE CHLORIDE	TRICHLORO ETHYLENE	BENZENE	PERCHLORO ETHYLENE	STYRENE	ETHYLENE DIBROMIDE	1,3- BUTADIEN
MINN CORRECTIONL	0.0004	0	0	0.0002	0	0	0	
JL SHIELY YARD A	0.0003	0	0	0.0001	0	0	0	
ST PAUL RIVER TE	0	0	0	0	0	0	0	
ST PAUL BRASS FO	0	0	0	0	0	0	0	
TOTAL	342.630811	423.168099	309.61566	228.544	82.685081	39.4178	9.024419	6.57309

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	ETHYLENE DICHLORIDE	ETHYLENE OXIDE	ACETAL DEHYDE	VINYL CHLORID	ACRYLO NITRILE	CADMIUM	ARSENIC	CARBON TET
ASHLAND ST PAUL	0.218748	0.006076	0.161457	0.13976	0.082465	0	0	0.026041
KOCH PINE BEND R	0.004082	0.095304	2.53236	2.19199	1.29341	0	0.002268	0.408446
UNISYS SHEPARD R	0	0	0	0	0	0	0	0
WOLKERSTORFER	0	0	0	0	0	0	0	0
SUPERIOR PLATING	0	0	0	0	0	0	0	0
UPSHER-SMITH LAB	0	0	0	0	0	0	0	0
FMC NAVAL INDUST	0	0	0	0	0	0.00002	0.00002	0
CONTROL DATA PC	0	0	0	0	0	0	0	0
HITCHCOCK INDUST	0	0	0	0	0	0.00692	0.006989	0
BUCKBEE-MEARS ST	0	0	0	0	0	0	0	0
ELECTRIC MACHINE	0	0	0	0	0	0	0	0
SUPER RADIATOR C	0	0	0	0	0	0	0	0
3M CHEMOLITE	5.48081	0	0	0	0	0.0005	0.004551	0
HONEYWELL DEFEN	0	0	0	0	0	0	0	0
ECOWATER SYSTEM	0	0	0	0	0	0	0	0
MINN VALLEY ENGI	0	0	0	0	0	0	0	0
AMOCO ROSEVILLE	0	0	0	0	0	0	0	0
ADC TELECOMMUNI	0	0	0	0	0	0	0	0
PIONEER METAL FI	0	0	0	0	0	0	0	0
ELECTROSTATIC FI	0	0	0	0	0	0	0	0
ANDERSEN	0	0	0	0	0	0.0353	0.014847	0
EATON HYDRAULICS	0	0	0	0	0	0	0	0
WILLIAMS ST PAUL	0	0	0	0	0	0	0	0
3M MAIN PLANT	0	0	0	0	0	0	0	0
HONEYWELL MIL 79	0	0	0	0	0	0	0	0
LINDBERG HEAT TR	0	0	0	0	0	0	0	0
NORTH STAR STEEL	0	0	0	0	0.896095	0.00297	0.002965	0
KOCH FUELS	0	0	0	0	0	0	0	0
FREMONT INDUSTRI	0	0	0	0	0	0	0	0
HONEYWELL MINNE	0	0	0	0	0	0	0	0
CONTROL DATA	0	0	0	0	0	0	0	0
MOBIL ST PAUL TE	0	0	0	0	0	0	0	0
HONEYWELL MIL 80	0	0	0	0	0	0	0	0
GENERAL FOAM MIN	0	0	0	0	0	0	0	0
MED-TEK	0	0	0	0	0	0	0	0
FEDERAL-HOFFMAN	0	0	0	0	0	0.0002	0.00003	0
NICO PRODUCTS	0	0	0	0	0	0	0	0
UNOCAL MARKETIN	0	0	0	0	0	0	0	0
ANCHOR HOCKING P	0	0	0	0	0	0	0	0
JOYNERS SILVER+E	0	0	0	0	0	0	0	0
PRECISION PLATNG	0	0	0	0	0	0	0	0
UNISYS INFORMN S	0	0	0	0	0	0	0	0
AMER NATL CAN 20	0	0	0	0	0	0	0	0
ONAN MFG FACIL	0.002591	0.00008	0.017482	0.00165	0.001	0	0	0.0003
NORTHWEST AIRLIN	0	0	0.83441	0	0	0	0	0
PROFESSNL PLATNG	0	0	0	0	0	0	0	0
ERICKSON PETROLE	0	0	0	0	0	0	0	0
INTERPLASTIC 554	0	0	0	0	0	0	0	0
FLOUR CITY ARCHI	0	0	0	0	0	0	0	0
BYSTROM BROTHER	0	0	0	0	0	0	0	0
MCLAUGHLIN 554 G	0	0	0	0	0	0	0	0
CONTINENTAL CAN	0	0	0	0	0	0	0	0
PROSPECT FOUNDR	0	0	0	0	0	0.00338	0.003382	0
WALDORF	0	0	0	0	0	0	0	0
ME INTERNATIONAL	0	0	0	0	0	0.0006	0	0
METRO WASTE MET	0	0	0	0	0	0.23681	0	0
AMERICAN LINEN S	0	0	0	0	0	0	0	0
U.MINN HOSPITAL	0	1.28005	0	0	0	0	0	0
PDI	0	0	0	0	0	0	0	0

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	ETHYLENE DICHLORIDE	ETHYLENE OXIDE	ACETAL DEHYDE	VINYL CHLORID	ACRYLO NITRILE	CADMIUM	ARSENIC	CARBON TET
PLATING INC	0.114306	0.003402	0.084369	0.0728	0.043545	0	0	0.01360
ANCHOR GLASS CO	0	0	0	0	0	0	0.025975	
FOTO MARK	0	0	0	0	0	0	0	
NORTHERN MALLEA	0	0	0	0	0	0.00228	0.002277	
SPARTAN MFG	0	0	0	0	0	0	0	
MPLS ENERGY MAIN	0	0	0.0002	0	0	0	0.001485	
MAXWELL COMM S	0	0	0.00006	0	0	0	0	
TOTAL ASPHALT CO	0	0	0	0	0	0.01171	0.01171	
SMITH FOUNDRY IR	0	0	0	0	0	0.0033	0.0033	
ABBOTT/NORTHWES	0	0.705343	0	0	0	0.0009	0.0001	
STONE CONTAINER	0	0	0.0002	0	0	0	0	
NATIONAL FOUNDR	0	0	0	0	0	0.00143	0.001426	
CS MCCROSSAN CO	0	0	0	0	0	0.00942	0.009418	
3M CHEMOLITE INC	0	0	0	0	0	0.00225	0.0004	
MCNAMARA CONTR	0	0	0	0	0	0.00165	0.00165	
VETERANS ADMIN	0	0.580604	0	0	0	0	0	
FAIRVIEW SOUTHDA	0	0.573347	0	0	0	0	0	
SCOTT-ATWATER F	0	0	0	0	0	0.00365	0.003649	
FORD MOTOR ASSE	0	0	0	0	0	0	0	
PIER FOUNDRY + PA	0	0	0	0	0	0.0003	0.0003	
METRO MED CTR	0	0.242674	0	0	0	0.0009	0.0001	
RIVERSIDE MEDCTR	0	0.457226	0	0	0	0	0	
TOWER ASPHALT	0	0	0	0	0	0.00328	0.003278	
INTERPLASTIC 551	0	0	0	0	0	0	0	
UNIVERSAL PLASTI	0	0	0	0	0	0	0	
ACROMETAL PROGR	0	0	0	0	0	0.0006	0.0006	
GOPHER SMELTING	0	0	0	0	0	0.29739	0.059876	
N ST PWR KING PL	0	0	0	0	0	0.00517	0.311469	
WM MUELLER + SON	0	0	0	0	0	0.0042	0.004198	
CENTRAL CASTINGS	0	0	0	0	0	0.0001	0.0002	
ATWATER GROUP B	0	0	0	0	0	0.00006	0.0002	
ASSOCIATED ASPH	0	0	0	0	0	0.00467	0.004674	
METRO WASTE SEN	0	0	0	0	0	0.09706	0	
ST PAUL RAMSEY M	0	0	0	0	0	0.00237	0.0004	
TAPEMARK	0	0	0	0	0	0	0	
TA SCHIFSKY + SON	0	0	0	0	0	0.00324	0.003241	
3M MAPLEWOOD CT	0	0	0	0	0	0	0	
HARDRIVES CEDAR	0	0	0	0	0	0.02011	0.02011	
HENN COUNTY MED	0	0.290756	0	0	0	0	0	
MIDW ASPHALT NE	0	0	0	0	0	0.00255	0.002551	
MPLS ASPHALT PLT	0	0	0	0	0	0.0036	0.003603	
MIDW ASPHALT EDE	0	0	0	0	0	0.00249	0.002486	
ACME FOUNDRY	0	0	0	0	0	0.00001	0.00002	
BUREAU OF ENGRAV	0	0	0	0	0	0	0	
N ST PWR RIVSIDE	0	0	0	0	0	8E-06	0.001365	
BURY + CARLSON PE	0	0	0	0	0	0.00187	0.001873	
PINE BEND PAVING	0	0	0	0	0	0.00228	0.002282	
ECONOMICS LABOR	0	0	0	0	0	0	0	
COLLEGE OF ST CA	0	0	0	0	0	0	0	
BITUM RDWY BARB	0	0	0	0	0	0.00211	0.002114	
HAMLINE UNIVERSI	0	0	0	0	0	0	0	
CONSOL. CONTNR 9	0	0	0	0	0	0.01225	0.04311	
BRYAN ROCK 29 PR	0	0	0	0	0	0.06473	0.064727	
STROH BREWERY	0	0	0	0	0	0.00002	0.00509	
UNISYS DEFENSE S	0	0	0	0	0	0	0	
ST P ASPHALT PLT	0	0	0	0	0	0.00808	0.008083	
COOK PAINT + VARN	0	0	0	0	0	0	0	
VELTEX CHEMICAL	0	0	0	0	0	0	0	
U.MINN MPLS CAMP	0	0	0	0	0	0.00179	0.002591	

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	ETHYLENE DICHLORIDE	ETHYLENE OXIDE	ACETALDEHYDE	VINYL CHLORID	ACRYLONITRILE	CADMIUM	ARSENIC	CARBON TET
CERTAINTEED SHEL	0	0	0	0	0	0.00109	0.001091	0
BRYAN ROCK 06 PR	0	0	0	0	0	0.05389	0.053894	0
CONSOL. CONTNR 4	0	0	0	0	0	0.01786	0.062869	0
N ST PWR INVER H	0	0	0.018512	0	0	0	0	0
GENERAL MILLS PU	0	0	0	0	0	0	0	0
BONGARDS CREAME	0	0	0.00001	0	0	0	0	0
COMML ASPHALT M	0	0	0	0	0	0.01189	0.011885	0
WILLIAMS ROSEMNT	0	0	0	0	0	0	0	0
DISTRICT ENERGY	0	0	0	0	0	0.00004	0.019178	0
NORTHERN NATURA	0	0	0.002313	0	0	0	0	0
N ST PWR HIGH BR	0	0	0	0	0	0.0002	0.045775	0
N ST PWR BLUE LK	0	0	0.012375	0	0	0	0	0
FLEISCHMANN-KURT	0	0	0	0	0	0	0	0
NORTHERN ASPHAL	0	0	0	0	0	0.00412	0.004117	0
TENNANT	0	0	0	0	0	0	0	0
N ST PWR BLK DOG	0	0	0	0	0	0.00493	0.030132	0
COMML ASPHALT P	0	0	0	0	0	0.00765	0.007647	0
COMML ASPHALT B	0	0	0	0	0	0.00732	0.007316	0
JL SHIELY LARSON	0	0	0	0	0	0.02249	0.022486	0
JACOB SCHMIDT BR	0	0	0	0	0	0	0	0
SPECTRO ALLOYS	0	0	0	0	0	0.0002	0.0002	0
VAN HOVEN	0	0	0	0	0	0	0	0
GLOBE BUILDING M	0	0	0	0	0	0.0002	0.0002	0
JL SHIELY SHAKOP	0	0	0	0	0	0.01431	0.014309	0
DEPT ARMY TCAAP	0	0	0	0	0	0	0	0
HONEYWELL RESIDE	0	0	0	0	0	0	0	0
GAF BUILDING MAT	0	0	0	0	0	0.0001	0.0001	0
LEEF BROTHERS	0	0	0	0	0	0	0	0
COMML ASPHALT E	0	0	0	0	0	0.00484	0.004838	0
AMER NATL CAN 54	0	0	0	0	0	0	0	0
COOP POWER ASSO	0	0	0.004326	0	0	0	0	0
NL CHEMICALS SPE	0	0	0	0	0	0	0	0
U.MINN ST PAUL C	0	0	0	0	0	0.0005	0.004256	0
HONEYMEAD PRODU	0	0	0	0	0	0.00009	0.0008	0
BITUM RDWY CEDA	0	0	0	0	0	0.00348	0.003482	0
RICHARDS ASPHALT	0	0	0	0	0	0	0	0
PILLSBURY RED RO	0	0	0	0	0	0.01463	0.001	0
PILLSBURY MPLS A	0	0	0	0	0	0	0	0
OWENS-CORNING FI	0	0	0	0	0	0.00005	0.00005	0
CARGILL DOMESTIC	0	0	0	0	0	0	0	0
HENNEPIN ENERGY	0	0	0	0	0	0.0008	0.008165	0
PACKER RIVER TER	0	0	0	0	0	0.00913	0.0004	0
LAND O LAKES AGR	0	0	0	0	0	0	0	0
PURINA MILLS BP	0	0	0	0	0	0	0	0
GROSS-GIVEN MFG	0	0	0	0	0	0	0	0
U.MINN MPLS SE S	0	0	0	0	0	0.0007	0.006073	0
RAHR MALTING SHA	0	0	0	0	0	0	0	0
AMER NATL CAN 21	0	0	0	0	0	0	0	0
ASHBACH CONSTRU	0	0	0	0	0	0.00114	0.001138	0
MEDALLION KITCHE	0	0	0	0	0	0	0	0
CON AGRA FLOUR M	0	0	0	0	0	0	0	0
VAN DALE	0	0	0	0	0	0	0	0
KOCH REFINING SU	0	0	0	0	0	0.00305	0	0
UNIMIN MINNESOTA	0	0	0	0	0	0	0	0
CONCORDIA COLLEG	0	0	0	0	0	0	0	0
HM SMYTH	0	0	0	0	0	0	0	0
MPLS ENERGY N RI	0	0	0	0	0	0	0	0
RED ROCK OF MINN	0	0	0	0	0	0	0	0
AMER NATL CAN 01	0	0	0	0	0	0	0	0

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	ETHYLENE DICHLORIDE	ETHYLENE OXIDE	ACETAL DEHYDE	VINYL CHLORID	ACRYLO NITRILE	CADMIUM	ARSENIC	CARBON TET
MINN CORRECTIONL	0	0	0	0	0	0	0	
JL SHIELY YARD A	0	0	0	0	0	0	0	
ST PAUL RIVER TE	0	0	0	0	0	0.0001	0.0001	
ST PAUL BRASS FO	0	0	0	0	0	6E-06	0.000006	
TOTAL	5.820537	4.234862	3.668074	2.4062	2.316515	1.0493	0.95649	0.448

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	CHLOROFORM	CHROME + 6	PROPYLENE OXIDE	PAHCS	BERYLLIUM	BENZO(A) PYRENE	DIOXIN	TOTAL
ASHLAND ST PAUL	0.003472	0.001134	0.001736	0.0004	0	0	0	283.141
KOCH PINE BEND R	0.054459	0.005897	0.02723	0.00102	0.0005	0	0	193.289
UNISYS SHEPARD R	0	0	0	0	0	0	0	175.983
WOLKERSTORFER	0	0	0	0	0	0	0	80.3456
SUPERIOR PLATING	0	0	0	0	0	0	0	48.1883
UPSHER-SMITH LAB	0	0	0	0	0	0	0	42.6381
FMC NAVAL INDUST	0	0.000004	0	0	0	0	0	42.4623
CONTROL DATA PC	0	0	0	0	0	0	0	37.7393
HITCHCOCK INDUST	0	0.0003	0	0	0	0	0	36.3762
BUCKBEE-MEARS ST	0	0.0000002	0	0	0	0	0	25.9885
ELECTRIC MACHINE	0	0	0	0	0	0	0	22.8996
SUPER RADIATOR C	0	0	0	0	0	0	0	22.1355
3M CHEMOLITE	0	0.00004	0	0	0	0	0	20.1326
HONEYWELL DEFEN	0	0	0	0	0	0	0	19.6173
ECOWATER SYSTEM	0	0	0	0	0	0	0	18.6079
MINN VALLEY ENGI	0	0	0	0	0	0	0	17.6903
AMOCO ROSEVILLE	0	0	0	0.00007	0	0	0	17.5909
ADC TELECOMMUNI	0	0	0	0	0	0	0	17.1233
PIONEER METAL FI	0	0	0	0	0	0	0	16.2791
ELECTROSTATIC FI	0	0	0	0	0	0	0	15.8568
ANDERSEN	0	0.00005	0	0	0	0	0	14.7101
EATON HYDRAULICS	0	0	0	0	0	0	0	14.5151
WILLIAMS ST PAUL	0	0	0	0.0003	0	0	0	13.5926
3M MAIN PLANT	0	0.0002	0	0	0	0	0	12.8346
HONEYWELL MIL 79	0	0	0	0	0	0	0	12.7131
LINDBERG HEAT TR	0	0	0	0	0	0	0	12.7007
NORTH STAR STEEL	0	0.004977	0	0	0	0	0	12.4124
KOCH FUELS	0	0	0	0.0002	0	0	0	12.2408
FREMONT INDUSTRI	0	0	0	0	0	0	0	10.8863
HONEYWELL MINNE	0	0	0	0	0	0	0	10.5235
CONTROL DATA	0	0	0	0	0	0	0	10.4327
MOBIL ST PAUL TE	0	0	0	0.00003	0	0	0	10.0149
HONEYWELL MIL 80	0	0	0	0	0	0	0	9.85092
GENERAL FOAM MIN	0	0	0	0	0	0	0	9.52554
MED-TEK	0	0	0	0	0	0	0	9.28967
FEDERAL-HOFFMAN	0	0.00003	0	0	0	0	0	8.83931
NICO PRODUCTS	0	0	0	0	0	0	0	7.25755
UNOCAL MARKETIN	0	0	0	0.00271	0	0	0	6.9792
ANCHOR HOCKING P	0	0	0	0	0	0	0	6.4946
JOYNERS SILVER + E	0	0	0	0	0	0	0	6.15395
PRECISION PLATNG	0	0	0	0	0	0	0	6.01016
UNISYS INFORMN S	0	0	0	0	0	0	0	5.45674
AMER NATL CAN 20	0	0	0	0	0	0	0	5.41195
ONAN MFG FACIL	0.00005	0	0.00002	0	0	0	0	5.01036
NORTHWEST AIRLIN	0	0	0	0	0	0	0	4.50974
PROFESSNL PLATNG	0	0	0	0	0	0	0	4.23387
ERICKSON PETROLE	0	0	0	0.0001	0	0	0	4.14398
INTERPLASTIC 554	0	0	0	0	0	0	0	3.85331
FLOUR CITY ARCHI	0	0.000008	0	0	0	0	0	3.84053
BYSTROM BROTHER	0	0	0	0	0	0	0	3.7195
MCLAUGHLIN 554 G	0	0	0	0	0	0	0	3.57072
CONTINENTAL CAN	0	0	0	0	0	0	0	3.1163
PROSPECT FOUNDR	0	0.0001	0	0	0	0	0	3.00684
WALDORF	0	0.0003	0	0	0	0	0	2.91453
ME INTERNATIONAL	0	0.0002	0	0	0	0	0	2.74806
METRO WASTE MET	0	0.0008	0	0	0	0	0	2.48757
AMERICAN LINEN S	0	0	0	0	0	0	0	1.35853
U.MINN HOSPITAL	0	0	0	0	0	0	0	1.28005
PDI	0	0	0	0	0	0	0	1.20203

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	CHLOROFORM	CHROME + 6	PROPYLENE OXIDE	PAHCS	BERYLLIUM	BENZO(A) PYRENE	DIOXIN	TOTAL
PLATING INC	0.002041	0	0.0007	0	0	0	0	1.187
ANCHOR GLASS CO	0	0	0	0	0	0	0	1.130
FOTO MARK	0	0	0	0	0	0	0	1.105
NORTHERN MALLEA	0	0.00008	0	0	0	0	0	1.081
SPARTAN MFG	0	0	0	0	0	0	0	1.023
MPLS ENERGY MAIN	0	0.0001	0	0	0	0	0	1.023
MAXWELL COMM S	0	0	0	0	0	0	0	0.9636
TOTAL ASPHALT CO	0	0.001991	0	0	0	0	0	0.877
SMITH FOUNDRY IR	0	0.0001	0	0	0	0	0	0.8679
ABBOTT/NORTHWES	0	0.000001	0	0	0	0	0	0.7858
STONE CONTAINER	0	0	0	0	0	0	0	0.7519
NATIONAL FOUNDR	0	0.00005	0	0	0	0	0	0.6656
CS MCCROSSAN CO	0	0.001601	0	0	0	0	0	0.6487
3M CHEMOLITE INC	0	0.000004	0	0	0	0	0	0.605
MCNAMARA CONTR	0	0.0003	0	0	0	0	0	0.5975
VETERANS ADMIN	0	0	0	0	0	0	0	0.5806
FAIRVIEW SOUTHDA	0	0	0	0	0	0	0	0.5733
SCOTT-ATWATER F	0	0.0001	0	0	0	0	0	0.5729
FORD MOTOR ASSE	0	0	0	0	0	0	0	0.5178
PIER FOUNDRY + PA	0	0.00001	0	0	0	0	0	0.5170
METRO MED CTR	0	0.000001	0	0	0	0	0	0.4679
RIVERSIDE MEDCTR	0	0	0	0	0	0	0	0.4572
TOWER ASPHALT	0	0.0006	0	0	0	0	0	0.4562
INTERPLASTIC 551	0	0	0	0	0	0	0	0.4535
UNIVERSAL PLASTI	0	0	0	0	0	0	0	0.4535
ACROMETAL PROGR	0	0.00004	0	0	0	0	0	0.4275
GOPHER SMELTING	0	0	0	0	0	0	0	0.3751
N ST PWR KING PL	0	0.003063	0	0	0	0	0	0.3733
WM MUELLER + SON	0	0.0007	0	0	0	0	0	0.3693
CENTRAL CASTINGS	0	0.000009	0	0	0	0	0	0.3665
ATWATER GROUP B	0	0.0000001	0	0	0	0	0	0.3632
ASSOCIATED ASPH	0	0.0008	0	0	0	0	0	0.3479
METRO WASTE SEN	0	0.0003	0	0	0	0	0	0.3415
ST PAUL RAMSEY M	0	0.000004	0	0	0	0	0	0.3404
TAPEMARK	0	0	0	0	0	0	0	0.3401
TA SCHIFSKY + SON	0	0.0006	0	0	0	0	0	0.3175
3M MAPLEWOOD CT	0	0.0002	0	0	0	0	0	0.3175
HARDRIVES CEDAR	0	0.003419	0	0	0	0	0	0.2948
HENN COUNTY MED	0	0	0	0	0	0	0	0.2907
MIDW ASPHALT NE	0	0.0004	0	0	0	0	0	0.2690
MPLS ASPHALT PLT	0	0.0006	0	0	0	0	0	0.2621
MIDW ASPHALT EDE	0	0.0004	0	0	0	0	0	0.2579
ACME FOUNDRY	0	0.0000009	0	0	0	0	0	0.2441
BUREAU OF ENGRAV	0	0	0	0	0	0	0	0.2267
N ST PWR RIVSIDE	0	0.00001	0	0	0	0	0	0.2132
BURY + CARLSON PE	0	0.0003	0	0	0	0	0	0.2113
PINE BEND PAVING	0	0.0004	0	0	0	0	0	0.2001
ECONOMICS LABOR	0	0	0	0	0	0	0	0.1889
COLLEGE OF ST CA	0	0	0	0	0	0	0	0.1871
BITUM RDWY BARB	0	0.0004	0	0	0	0	0	0.1725
HAMLINE UNIVERSI	0	0	0	0	0	0	0	0.1373
CONSOL. CONTNR 9	0	0	0	0	0	0	0	0.1341
BRYAN ROCK 29 PR	0	0	0	0	0	0	0	0.1294
STROH BREWERY	0	0.00007	0	0	0	0	0	0.128
UNISYS DEFENSE S	0	0	0	0	0	0	0	0.1203
ST P ASPHALT PLT	0	0.001374	0	0	0	0	0	0.1189
COOK PAINT + VARN	0	0	0	0	0	0	0	0.1133
VELTEX CHEMICAL	0	0	0	0	0	0	0	0.1133
U.MINN MPLS CAMP	0	0.00001	0	0	0	0	0	0.1103

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	CHLOROFORM	CHROME + 6	PROPYLENE OXIDE	PAHCS	BERYLLIUM	BENZO(A) PYRENE	DIOXIN	TOTAL
CERTAINTEED SHEL	0	0.0005	0	0	0	0	0	0.109332
BRYAN ROCK 06 PR	0	0	0	0	0	0	0	0.107788
CONSOL. CONTNR 4	0	0	0	0	0	0	0	0.101527
N ST PWR INVER H	0	0	0	0	0	0	0	0.094711
GENERAL MILLS PU	0	0.000002	0	0	0	0	0	0.091744
BONGARDS CREAME	0	0.00001	0	0	0	0	0	0.084844
COMML ASPHALT M	0	0.00202	0	0	0	0	0	0.081468
WILLIAMS ROSEMNT	0	0	0	0.00007	0	0	0	0.0761
DISTRICT ENERGY	0	0.0002	0	0	0	0	0	0.074204
NORTHERN NATURA	0	0	0	0	0	0	0	0.073232
N ST PWR HIGH BR	0	0.0005	0	0	0	0	0	0.066517
N ST PWR BLUE LK	0	0	0	0	0	0	0	0.063312
FLEISCHMANN-KURT	0	0	0	0	0	0	0	0.061003
NORTHERN ASPHAL	0	0.0007	0	0	0	0	0	0.059436
TENNANT	0	0	0	0	0	0	0	0.057437
N ST PWR BLK DOG	0	0.0003	0	0	0	0	0	0.05348
COMML ASPHALT P	0	0.0013	0	0	0	0	0	0.049482
COMML ASPHALT B	0	0.001244	0	0	0	0	0	0.046743
JL SHIELY LARSON	0	0	0	0	0	0	0	0.044972
JACOB SCHMIDT BR	0	0	0	0	0	0	0	0.043741
SPECTRO ALLOYS	0	0.0002	0	0	0	0	0	0.040412
VAN HOVEN	0	0.00002	0	0	0	0	0	0.03755
GLOBE BUILDING M	0	0.0003	0	0	0	0	0	0.036826
JL SHIELY SHAKOP	0	0	0	0	0	0	0	0.03208
DEPT ARMY TCAAP	0	0	0	0	0	0	0	0.031777
HONEYWELL RESIDE	0	0	0	0	0	0	0	0.027322
GAF BUILDING MAT	0	0.0002	0	0	0	0	0	0.026086
LEEF BROTHERS	0	0	0	0	0	0	0	0.024696
COMML ASPHALT E	0	0.0008	0	0	0	0	0	0.023387
AMER NATL CAN 54	0	0	0	0	0	0	0	0.023368
COOP POWER ASSO	0	0	0	0	0	0	0	0.022134
NL CHEMICALS SPE	0	0.000007	0	0	0	0	0	0.021241
U.MINN ST PAUL C	0	0.00004	0	0	0	0	0	0.020784
HONEYMEAD PRODU	0	0.000007	0	0	0	0	0	0.020187
BITUM RDWY CEDA	0	0.0006	0	0	0	0	0	0.019961
RICHARDS ASPHALT	0	0.015719	0	0	0	0	0	0.017653
PILLSBURY RED RO	0	0	0	0	0	0	0	0.01559
PILLSBURY MPLS A	0	0	0	0	0	0	0	0.015546
OWENS-CORNING FI	0	0.0005	0	0	0	0	0	0.013796
CARGILL DOMESTIC	0	0.00001	0	0	0	0	0	0.013171
HENNEPIN ENERGY	0	0.000005	0	0	0.0008	0.0004	9E-08	0.010165
PACKER RIVER TER	0	0	0	0	0	0	0	0.009897
LAND O LAKES AGR	0	0.000007	0	0	0	0	0	0.008702
PURINA MILLS BP	0	0.0000002	0	0	0	0	0	0.008269
GROSS-GIVEN MFG	0	0	0	0	0	0	0	0.008078
U.MINN MPLS SE S	0	0.00005	0	0	0	0	0	0.006784
RAHR MALTING SHA	0	0	0	0	0	0	0	0.006058
AMER NATL CAN 21	0	0	0	0	0	0	0	0.004904
ASHBACH CONSTRU	0	0.0002	0	0	0	0	0	0.003853
MEDALLION KITCHE	0	0	0	0	0	0	0	0.00375
CON AGRA FLOUR M	0	0	0	0	0	0	0	0.003353
VAN DALE	0	0	0	0	0	0	0	0.003215
KOCH REFINING SU	0	0	0	0	0	0	0	0.003049
UNIMIN MINNESOTA	0	0	0	0	0	0	0	0.002885
CONCORDIA COLLEG	0	0	0	0	0	0	0	0.002591
HM SMYTH	0	0	0	0	0	0	0	0.002019
MPLS ENERGY N RI	0	0	0	0	0	0	0	0.001219
RED ROCK OF MINN	0	0.001153	0	0	0	0	0	0.001153
AMER NATL CAN 01	0	0	0	0	0	0	0	0.0006

Appendix A - Table IV-1A: Point Source Inventory Results (metric tons/yr)

FACILITY	CHLOROFORM	CHROME+6	PROPYLENE OXIDE	PAHCS	BERYLLIUM	BENZO(A) PYRENE	DIOXIN	TOTAL
MINN CORRECTIONL	0	0	0	0	0	0	0	0.000
JL SHIELY YARD A	0	0	0	0	0	0	0	0.000
ST PAUL RIVER TE	0	0	0	0	0	0	0	0.000
ST PAUL BRASS FO	0	0.000001	0	0	0	0	0	0.0000
TOTAL	0.060022	0.0586734	0.029686	0.0049	0.0013	0.0004	9E-08	1462.714

Appendix A - Table VII-1A: Point Source Excess Incidence Results

FACILITY	ARSENIC	ETHYLENE OXIDE	BENZENE	ETHYLENE DIBROMIDE	1,3-BUTADIENE
ASHLAND ST PAUL	0	0	0.012674	0	0.287388
CONSOL. CONTNR 4	0.204703	0	0	0	0
FMC NAVAL INDUST	0	0	0	0.100946	0
AMER NATL CAN 20	0	0	0	0.119235	0
U.MINN HOSPITAL	0	0.116936	0	0	0
ABBOTT/NORTHWEST	0	0.086611	0	0	0
KOCH PINE BEND R	0.0002	0	0.074308	0	0
UNISYS SHEPARD R	0	0	0	0	0
CONSOL. CONTNR 9	0.064645	0	0	0.001931	0
WOLKERSTORFER	0	0	0	0.023044	0
KOCH FUELS	0	0	0.058882	0	0
WILLIAMS ST PAUL	0	0	0.055153	0	0
BRYAN ROCK 29 PR	0.035849	0	0	0	0
MOBIL ST PAUL TE	0	0	0.04747	0	0
NORTHWEST AIRLIN	0	0	0.0003	0	0.032962
TOTAL ASPHALT CO	0.024228	0	0.00006	0	0
RIVERSIDE MEDCTR	0	0.044025	0	0	0
FLOUR CITY ARCHI	0	0	0.009641	0	0
AMOCO ROSEVILLE	0	0	0.039529	0	0
WALDORF	0	0	0	0.038111	0
BRYAN ROCK 06 PR	0.027258	0	0	0	0
SUPERIOR PLATING	0	0	0	0	0
PROSPECT FOUNDRY	0.009971	0	0.020851	0	0
FAIRVIEW SOUTHDA	0	0.034483	0	0	0
UNOCAL MARKETING	0	0	0.031175	0	0
HENN COUNTY MED	0	0.031106	0	0	0
VETERANS ADMIN M	0	0.03026	0	0	0
FEDERAL-HOFFMAN	0	0	0	0.030241	0
ST PAUL PIONEER	0	0	0	0	0
GOPHER SMELTING +	0.007911	0	0	0	0
METRO MED CTR	0	0.02651	0	0	0
METRO WASTE METR	0	0	0.00009	0	0
BUCKBEE-MEARS ST	0	0	0	0.016819	0
ELECTRIC MACHINE	0	0	0	0	0
ELECTROSTATIC FI	0	0	0	0.01101	0
PIONEER METAL FI	0	0	0	0	0
PRECISION PLATNG	0	0	0	0	0
HONEYWELL MIL 79	0	0	0	0	0
COMML ASPHALT MA	0.008168	0	0	0	0
RICHARDS ASPHALT	0	0	0	0	0
MPLS ASPHALT PLT	0.007646	0	0	0	0
LINDBERG HEAT TR	0	0	0	0	0
MED-TEK	0	0	0	0	0
ST P ASPHALT PLT	0.006241	0	0	0	0
3M CHEMOLITE	0	0	0	0	0
JL SHIELY LARSON	0.008197	0	0	0	0
GILLETTE ST PAUL	0	0	0	0	0
COMML ASPHALT PL	0.005928	0	0	0	0
MCGILL-JENSEN	0	0	0	0	0
CONTROL DATA PCO	0	0	0	0	0
3M MAIN PLANT	0	0	0	0	0
ONAN MFG FACIL	0	0	0.00007	0	0.009258
HONEYWELL MIL 80	0	0	0	0	0
NICO PRODUCTS	0	0	0	0	0
AMERICAN LINEN S	0	0	0.001315	0	0
METRO WASTE SENE	0	0	0	0	0
PACKER RIVER TER	0.0003	0	0	0	0
CS MCCROSSAN CON	0.004092	0	0.00001	0	0

Appendix A - Table VII-1A: Point Source Excess Incidence Results

FACILITY	ARSENIC	ETHYLENE OXIDE	BENZENE	ETHYLENE DIBROMIDE	1,3-BUTADIENE
MAXWELL COMM FRI	0	0	0	0	0
SUPER RADIATOR C	0	0	0	0	0
ERICKSON PETROLE	0	0	0.00604	0	0
U.MINN MPLS CAMP	0.004341	0	0	0	0
TA SCHIFSKY+SONS	0.003002	0	0.00001	0	0
THE PRESS	0	0	0	0	0
NATIONAL FOUNDRY	0.001418	0	0.003026	0	0
HITCHCOCK INDUST	0.0002	0	0	0	0
PILLSBURY RED RO	0.0003	0	0	0	0
PLATING INC	0	0	0.0004	0	0.002585
SCOTT-ATWATER FO	0.002316	0	0.0006	0	0
UPSHER-SMITH LAB	0	0	0	0	0
BURY+CARLSON PER	0.002018	0	0	0	0
JL SHIELY SHAKOP	0.002588	0	0	0	0
ANCHOR GLASS CON	0.002932	0	0	0	0
GAINES+HANSON PR	0	0	0	0	0
COMML ASPHALT BU	0.001698	0	0	0	0
RED ROCK OF MINN	0	0	0	0	0
ME INTERNATIONAL	0	0	0.001647	0	0
NORTH STAR STEEL	0	0	0	0	0
COMML ASPHALT EM	0.001026	0	0	0	0
HONEYWELL DEFENS	0	0	0	0	0
JOYNERS SILVER+E	0	0	0	0	0
STONE CONTAINER	0	0	0	0	0
ECOWATER SYSTEMS	0	0	0	0	0
N ST PWR BLK DOG	0.0008	0	0	0	0
NORTHERN ASPHALT	0.0005	0	0	0	0
HARDRIVES CEDAR	0.0005	0	0	0	0
MIDW ASPHALT NEW	0.0003	0	0	0	0
BITUM RDWY CEDAR	0.0004	0	0	0	0
MIDW ASPHALT EDE	0.0002	0	0	0	0
ASSOCIATED ASPHA	0.0001	0	0	0	0
BITUM RDWY BARBR	0.0001	0	0	0	0
DISTRICT ENERGY	0.00007	0	0	0	0
STROH BREWERY	0.00006	0	0	0	0
WM MUELLER+SONS	0.00004	0	0	0	0
PINE BEND PAVING	0.00002	0	0	0	0
N ST PWR KING PL	0.00001	0	0	0	0
TOWER ASPHALT	0.00001	0	0	0	0
TOTAL	0.440286	0.369931	0.363251	0.341337	0.332193

Appendix A - Table VII-1A: Point Source Excess Incidence Results

FACILITY	FORMAL DEHYDE	TRICHLORO ETHYLENE	CADMIUM	METHYLENE CHLORIDE	CHROME + 6
ASHLAND ST PAUL	0.112557	0	0	0	0
CONSOL. CONTNR 4	0	0	0.024233	0	0
FMC NAVAL INDUST	0	0.019114	0	0.00002	0
AMER NATL CAN 20	0	0	0	0.00001	0
U.MINN HOSPITAL	0	0	0	0	0
ABBOTT/NORTHWEST	0	0	0	0	0
KOCH PINE BEND R	0.002027	0	0	0	0
UNISYS SHEPARD R	0	0.045125	0	0.030132	0
CONSOL. CONTNR 9	0	0	0.007185	0	0
WOLKERSTORFER	0	0.043979	0	0.003337	0
KOCH FUELS	0	0	0	0	0
WILLIAMS ST PAUL	0	0	0	0	0
BRYAN ROCK 29 PR	0	0	0.013056	0	0
MOBIL ST PAUL TE	0	0	0	0	0
NORTHWEST AIRLIN	0.012653	0	0	0	0
TOTAL ASPHALT CO	0.0009	0	0.009418	0	0.010866
RIVERSIDE MEDCTR	0	0	0	0	0
FLOUR CITY ARCHI	0.031679	0	0	0	0
AMOCO ROSEVILLE	0	0	0	0	0
WALDORF	0	0	0	0	0
BRYAN ROCK 06 PR	0	0	0.009283	0	0
SUPERIOR PLATING	0	0.035875	0	0	0
PROSPECT FOUNDRY	0.0003	0	0.003196	0	0.0005
FAIRVIEW SOUTHDA	0	0	0	0	0
UNOCAL MARKETING	0	0	0	0	0
HENN COUNTY MED	0	0	0	0	0
VETERANS ADMIN M	0	0	0	0	0
FEDERAL-HOFFMAN	0	0	0	0	0
ST PAUL PIONEER	0.028155	0	0	0	0
GOPHER SMELTING +	0	0	0.019093	0	0
METRO MED CTR	0	0	0	0	0
METRO WASTE METR	0	0	0.023388	0	0
BUCKBEE-MEARS ST	0	0	0	0.001782	0
ELECTRIC MACHINE	0	0	0	0	0
ELECTROSTATIC FI	0	0	0	0.004138	0
PIONEER METAL FI	0	0.014781	0	0	0
PRECISION PLATNG	0	0.014212	0	0	0
HONEYWELL MIL 79	0	0.013616	0	0	0
COMML ASPHALT MA	0	0	0.002271	0	0.002858
RICHARDS ASPHALT	0	0	0	0	0.013249
MPLS ASPHALT PLT	0.00006	0	0.002281	0	0.002777
LINDBERG HEAT TR	0	0.012596	0	0	0
MED-TEK	0	0.011493	0	0	0
ST P ASPHALT PLT	0	0	0.002344	0	0.002742
3M CHEMOLITE	0	0	0	0.00007	0
JL SHIELY LARSON	0	0	0.002532	0	0
GILLETTE ST PAUL	0	0.010617	0	0	0
COMML ASPHALT PL	0	0	0.002077	0	0.002418
MCGILL-JENSEN	0.010236	0	0	0	0
CONTROL DATA PCO	0	0	0	0.010076	0
3M MAIN PLANT	0.009892	0	0	0	0
ONAN MFG FACIL	0.00001	0	0	0	0
HONEYWELL MIL 80	0	0.008475	0	0	0
NICO PRODUCTS	0	0.008215	0	0	0
AMERICAN LINEN S	0.006269	0	0	0	0
METRO WASTE SENE	0	0	0.007098	0	0
PACKER RIVER TER	0	0	0.006647	0	0
CS MCCROSSAN CON	0.0001	0	0.001076	0	0.001293

Appendix A - Table VII-1A: Point Source Excess Incidence Results

FACILITY	FORMAL DEHYDE	TRICHLORO ETHYLENE	CADMIUM	METHYLENE CHLORIDE	CHROME + 6
MAXWELL COMM FRI	0.006336	0	0	0	0
SUPER RADIATOR C	0	0	0	0	0
ERICKSON PETROLE	0	0	0	0	0
U.MINN MPLS CAMP	0	0	0.001337	0	0
TA SCHIFSKY + SONS	0.0001	0	0.001086	0	0.001253
THE PRESS	0.005404	0	0	0	0
NATIONAL FOUNDRY	0	0	0.0002	0	0
HITCHCOCK INDUST	0	0	0	0	0
PILLSBURY RED RO	0	0	0.003709	0	0
PLATING INC	0.00008	0	0	0	0
SCOTT-ATWATER FO	0	0	0.0005	0	0.00001
UPSHER-SMITH LAB	0	0	0	0.003216	0
BURY + CARLSON PER	0	0	0.0005	0	0.0006
JL SHIELY SHAKOP	0	0	0.0005	0	0
ANCHOR GLASS CON	0	0	0	0	0
GAINES + HANSON PR	0.002877	0	0	0	0
COMML ASPHALT BU	0	0	0.0004	0	0.0005
RED ROCK OF MINN	0	0	0	0	0.00207
ME INTERNATIONAL	0	0	0	0	0.00006
NORTH STAR STEEL	0	0	0	0	0.0005
COMML ASPHALT EM	0	0	0.0002	0	0.0002
HONEYWELL DEFENS	0	0.001264	0	0	0
JOYNERS SILVER + E	0	0.00114	0	0	0
STONE CONTAINER	0.001067	0	0	0	0
ECOWATER SYSTEMS	0	0	0	0.0007	0
N ST PWR BLK DOG	0	0	0.00008	0	0
NORTHERN ASPHALT	0	0	0.0001	0	0.0002
HARDRIVES CEDAR	0	0	0.00006	0	0.00008
MIDW ASPHALT NEW	0.00005	0	0.00008	0	0.00009
BITUM RDWY CEDAR	0	0	0.00007	0	0.00008
MIDW ASPHALT EDE	0.00003	0	0.00005	0	0.00005
ASSOCIATED ASPHA	0	0	0.00004	0	0.00004
BITUM RDWY BARBR	0	0	0	0	0
DISTRICT ENERGY	0	0	0	0	0
STROH BREWERY	0	0	0	0	0
WM MUELLER + SONS	0	0	0	0	0
PINE BEND PAVING	0	0	0	0	0
N ST PWR KING PL	0	0	0	0	0
TOWER ASPHALT	0	0	0	0	0
TOTAL	0.230782	0.240502	0.14409	0.053481	0.042436

Appendix A - Table VII-1A: Point Source Excess Incidence Results

FACILITY	PERCHLORO ETHYLENE	ETHYLENE DICHLORIDE	ACRYLO NITRILE	STYRENE	ACETALDEHYDE	TOTAL
ASHLAND ST PAUL	0	0	0	0	0	0.412619
CONSOL. CONTNR 4	0	0	0	0	0	0.228936
FMC NAVAL INDUST	0	0	0	0	0	0.120083
AMER NATL CAN 20	0	0	0	0	0	0.119246
U.MINN HOSPITAL	0	0	0	0	0	0.116936
ABBOTT/NORTHWEST	0	0	0	0	0	0.086611
KOCH PINE BEND R	0	0	0.0006	0	0	0.077153
UNISYS SHEPARD R	0	0	0	0	0	0.075257
CONSOL. CONTNR 9	0	0	0	0	0	0.073761
WOLKERSTORFER	0	0	0	0	0	0.07036
KOCH FUELS	0	0	0	0.00005	0	0.058931
WILLIAMS ST PAUL	0	0	0	0.00004	0	0.05519
BRYAN ROCK 29 PR	0	0	0	0	0	0.048905
MOBIL ST PAUL TE	0	0	0	0.00005	0	0.047517
NORTHWEST AIRLIN	0	0	0	0	0.0001	0.046031
TOTAL ASPHALT CO	0	0	0	0	0	0.04546
RIVERSIDE MEDCTR	0	0	0	0	0	0.044025
FLOUR CITY ARCHI	0	0	0	0	0	0.04132
AMOCO ROSEVILLE	0	0	0	0	0	0.039529
WALDORF	0	0	0	0	0	0.038111
BRYAN ROCK 06 PR	0	0	0	0	0	0.036542
SUPERIOR PLATING	0	0	0	0	0	0.035875
PROSPECT FOUNDRY	0	0	0	0	0	0.034812
FAIRVIEW SOUTHDA	0	0	0	0	0	0.034483
UNOCAL MARKETING	0	0	0	0.00002	0	0.031192
HENN COUNTY MED	0	0	0	0	0	0.031106
VETERANS ADMIN M	0	0	0	0	0	0.03026
FEDERAL-HOFFMAN	0	0	0	0	0	0.030241
ST PAUL PIONEER	0	0	0	0	0	0.028155
GOPHER SMELTING +	0	0	0	0	0	0.027004
METRO MED CTR	0	0	0	0	0	0.02651
METRO WASTE METR	0	0	0	0	0	0.023474
BUCKBEE-MEARS ST	0	0	0	0	0	0.018601
ELECTRIC MACHINE	0.015345	0	0	0	0	0.015345
ELECTROSTATIC FI	0	0	0	0	0	0.015148
PIONEER METAL FI	0	0	0	0	0	0.014781
PRECISION PLATNG	0	0	0	0	0	0.014212
HONEYWELL MIL 79	0	0	0	0	0	0.013616
COMML ASPHALT MA	0	0	0	0	0	0.013297
RICHARDS ASPHALT	0	0	0	0	0	0.013249
MPLS ASPHALT PLT	0	0	0	0	0	0.012761
LINDBERG HEAT TR	0	0	0	0	0	0.012596
MED-TEK	0	0	0	0	0	0.011493
ST P ASPHALT PLT	0	0	0	0	0	0.011327
3M CHEMOLITE	0	0.011254	0	0	0	0.011325
JL SHIELY LARSON	0	0	0	0	0	0.010729
GILLETTE ST PAUL	0	0	0	0	0	0.010617
COMML ASPHALT PL	0	0	0	0	0	0.010423
MCGILL-JENSEN	0	0	0	0	0	0.010236
CONTROL DATA PCO	0	0	0	0	0	0.010076
3M MAIN PLANT	0	0	0	0	0	0.009892
ONAN MFG FACIL	0	0	0	0	0	0.009342
HONEYWELL MIL 80	0	0	0	0	0	0.008475
NICO PRODUCTS	0	0	0	0	0	0.008215
AMERICAN LINEN S	0	0	0	0	0	0.007584
METRO WASTE SENE	0	0	0	0	0	0.007098
PACKER RIVER TER	0	0	0	0	0	0.006956
CS MCCROSSAN CON	0	0	0	0	0	0.006592

Appendix A - Table VII-1A: Point Source Excess Incidence Results

FACILITY	PERCHLORO ETHYLENE	ETHYLENE DICHLORIDE	ACRYLO NITRILE	STYRENE	ACETALDEHYDE	TOTAL
MAXWELL COMM FRI	0	0	0	0	0	0.006336
SUPER RADIATOR C	0.006118	0	0	0	0	0.006118
ERICKSON PETROLE	0	0	0	0	0	0.00604
U.MINN MPLS CAMP	0	0	0	0	0	0.005678
TA SCHIFSKY + SONS	0	0	0	0	0	0.005497
THE PRESS	0	0	0	0	0	0.005404
NATIONAL FOUNDRY	0	0	0	0	0	0.004613
HITCHCOCK INDUST	0.004031	0	0	0	0	0.004187
PILLSBURY RED RO	0	0	0	0	0	0.00404
PLATING INC	0	0.0003	0.0003	0	0	0.003604
SCOTT-ATWATER FO	0	0	0	0	0	0.003402
UPSHER-SMITH LAB	0	0	0	0	0	0.003216
BURY + CARLSON PER	0	0	0	0	0	0.003163
JL SHIELY SHAKOP	0	0	0	0	0	0.003083
ANCHOR GLASS CON	0	0	0	0	0	0.002932
GAINES + HANSON PR	0	0	0	0	0	0.002877
COMML ASPHALT BU	0	0	0	0	0	0.002519
RED ROCK OF MINN	0	0	0	0	0	0.00207
ME INTERNATIONAL	0	0	0	0	0	0.001705
NORTH STAR STEEL	0	0	0.001189	0	0	0.001656
COMML ASPHALT EM	0	0	0	0	0	0.001402
HONEYWELL DEFENS	0	0	0	0	0	0.001264
JOYNERS SILVER + E	0	0	0	0	0	0.00114
STONE CONTAINER	0	0	0	0	0	0.001067
ECOWATER SYSTEMS	0	0	0	0.0002	0	0.001
N ST PWR BLK DOG	0	0	0	0	0	0.0009
NORTHERN ASPHALT	0	0	0	0	0	0.0008
HARDRIVES CEDAR	0	0	0	0	0	0.0007
MIDW ASPHALT NEW	0	0	0	0	0	0.0006
BITUM RDWY CEDAR	0	0	0	0	0	0.0005
MIDW ASPHALT EDE	0	0	0	0	0	0.0003
ASSOCIATED ASPHA	0	0	0	0	0	0.0002
BITUM RDWY BARBR	0	0	0	0	0	0.0001
DISTRICT ENERGY	0	0	0	0	0	0.00007
STROH BREWERY	0	0	0	0	0	0.00006
WM MUELLER + SONS	0	0	0	0	0	0.00004
PINE BEND PAVING	0	0	0	0	0	0.00002
N ST PWR KING PL	0	0	0	0	0	0.00001
TOWER ASPHALT	0	0	0	0	0	0.00001
TOTAL	0.025494	0.011554	0.002089	0.00036	0.0001	2.597944

APPENDIX B

DETAILED AREA SOURCE EMISSIONS DETERMINATION

I. Service Station Gasoline Emissions
II. Drycleaning Emissions
III. Ethylene Oxide Sterilizers
    A. Hospital Ethylene Oxide Sterilizers
    B. Research Laboratories Ethylene Oxide Sterilizers
IV. Industrial Cooling Towers
V. Comfort Cooling Towers
VI. Chrome Plating
VII. Surface Coating
VIII. Degreasing
IX. Commercial/Consumer Solvent Use
X. Small Commercial Incinerators
XI. Waste Oil Combustion
XII. Industrial Area Source Heating
    A. Distillate Oil
    B. Natural Gas
XIII. Commercial/Institutional Heating
    A. Distillate Oil
    B. Residual Oil
    C. Natural Gas
XIV. Residential Heating
    A. Distillate Oil
    B. Natural Gas
XV. Residential Woodburning

I. SERVICE STATION GASOLINE EMISSIONS

Total air emissions from gasoline service stations include:

1. Filling of underground storage tanks - emissions are generated when vapors in the underground storage tank are displaced to the atmosphere by the gasoline being loaded into the tank. The quantity of emissions is dependent upon the method used to fill the tank. According to Brian Ettesvold of the Minnesota Service Station Association, the majority of service stations in Minnesota employ the splash fill method of filling underground storage tanks. The emission factor used in the calculations below is for the splash fill method.

   Breathing losses - losses from underground storage tanks resulting from daily changes in temperature and barometric pressure. Emission factor used is for an average service station.

3. Spillage - emission factor used is for an average service station.

note: Vehicle refueling emissions for benzene are calculated and included in MOBILE4 output. Vehicle refueling emissions for ethylene dichloride and ethylene dibromide are included in the totals below.

TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR GASOLINE SERVICE STATIONS

POLLUTANT	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Benzene	4,424	774	4,945	23,700	11,060	1,501	2,291
Ethylene Dichloride	680	119	764	3,639	1,699	230	352
Ethylene Dibromide	68	12	76	364	169	23	35

METHODOLOGY

1) Total statewide gasoline consumption for 1987 = 2 billion gallons (Highway Statistics, 1987. U.S. Department of Transportation. Federal Highway Administration).

2) Using 1982 Census of Retail Trade data, calculate service station percent of state sales by county.

3) Multiply county percent of state sales by the appropriate emission factors to determine emissions of benzene, ethylene dichloride, and ethylene dibromide from:
   a)filling of underground storage tanks,
   b)breathing losses, and
   c) spillage.

4) Sum the emissions from these three activities to arrive at county-wide emissions of benzene, ethylene dichloride, and ethylene dibromide.

Apportioning

Apportion service station emissions from county totals by population.

References

1) Procedures for Estimating and Allocating Area Source Emissions of Air Toxics, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1989.

2) Procedures for the Preparation of Emission Inventories for Precursors of Ozone.

3) Locating and Estimating Air Emission from Sources of Benzene EPA-450/4-84-007q.

4) Highway Statistics, 1987. U.S. Department of Transportation, Federal Highway Administration

5) 1982 Census of Retail Trade

II. DRYCLEANING EMISSIONS

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR DRY CLEANING ESTABLISHMENTS COUNTY (# OF EMPLOYEES IN SIC 721)*						
	Anoka (237)	Carver (132)**	Dakota (228)	Hennepin (2,502)	Ramsey (611)	Scott (54)	Washington (55)
Perchloroethylene	85,320	47,520	82,080	900,720	219,960	19,440	19,800

* Employment data from: County Business Patterns, 1986. U.S. Department of Commerce, Bureau of the Census

** Employment data for Carver county were available only for SIC code 72 and therefore the emissions will be overestimated.

Methodology

1) Determine county-wide employment for SIC code 721 from County Business Patterns. This method will provide a conservative estimate as it is based on employment in SIC code 721. A more refined approach would be to determine employment for SIC codes 7215, 7216, and 7218. This information was not available for the counties in this study.

2) Apply emission factor of 360 lb/yr/employee of perchloroethylene From: Procedures for Estimating and Allocating Area Source Emissions of Air Toxics. March 1989.

3) No point source emissions for drycleaning were found in NEDS.

Apportioning

Apportion drycleaning emissions from county totals by population.

References

1) USEPA, Procedures for Estimating and Allocating Area Source Emissions of Air Toxics. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. March 1989.

2) USEPA. Survey of Perchloroethylene Emission Sources. EPA-450/3-85-017. Office of Air Quality Planning and Standards, Research Triangle Park, NC, 1985.

3) USEPA. Locating and Estimating Air Emissions from Sources of Perchloroethylene and Trichloroethylene. EPA-450/2-89-013. OAQPS, RTP, NC. August 1989.

4) County Business Patterns, 1986. U.S. Dept; of Commerce, Bureau of the Census.

III. ETHYLENE OXIDE STERILIZERS

A. HOSPITAL ETHYLENE OXIDE STERILIZERS

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR HOSPITAL ETHYLENE OXIDE STERILIZERS						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Ethylene Oxide	1,160	185	513	2,555	2,843	190	222

METHODOLOGY

1) List the hospitals and their respective number of beds in each county. From: American Hospital Association Guide to the Health Care Field. 1987 Edition.

2) Using the following emission factors, estimate the emissions from each hospital:
   a) Large Hospitals (>500 beds) 1.8 lb/bed/yr
   b) Medium Hospitals(200-500 beds) 1.3 lb/bed/yr
   c) Small Hospitals (<200 beds) 1.7 lb/bed/yr

   From: Procedures for Estimating and Allocating Area Source Emissions of Air Toxics. March 1989.

3) Sum the emissions for each county subtracting out those that will be treated as point sources. Hospitals with estimated emissions greater than 500 lb/yr are treated as point sources. Those hospitals are:

Anoka County

none

Carver County

none

Dakota County

none

Hennepin County

a) Veterans Administration — 1280 lb/yr *
Minneapolis, MN
location: 483.8, 4971.7

b) University of MN Hospital — 2822 lb/yr *
Minneapolis, MN
location: 482.6, 4979.6

c) Hennepin County Medical Ctr — 641 lb/yr
Minneapolis, MN
location: 479.3, 4979.9

d) Metropolitan Medical Center — 535 lb/yr *
Minneapolis, MN
location: 479.4, 4979.9

e) Fairview Southdale Hospital — 1264 lb/yr *
Edina, MN
location: 474.2, 4970.2

f) Riverside Medical Center — 1008 lb/yr *
Minneapolis, MN
location: 481.3, 4979.4

g) Abbott-Northwestern — 1555 lb/yr *
Minneapolis, MN
location: 479.4, 4977.6

* Verified by telephone with the hospital

Ramsey County

none

Scott County

none

Washington County

none

Apportioning

Model large facilities as point sources. Apportion county emissions by population.

References

1) USEPA, Procedures for Estimating and Allocating Area Source Emissions of Air Toxics, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March 1989.

2) USEPA, Locating and Estimating Air Emissions From Sources of Ethylene Oxide, EPA-450/4-84-007l, OAQPS, RTP, NC. September 1986.

3) USEPA, Alternative Control Technology Document-Ethylene Oxide Sterilization/ Fumigation Operations. EPA-450/3-89-007. OAQPS, RTP, NC. March 1989.

4) American Hospital Association Guide to the Health Care Field. 1987

B. RESEARCH LABORATORIES ETHYLENE OXIDE STERILIZERS

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR RESEARCH LABORATORIES ETHYLENE OXIDE STERILIZERS COUNTY (1980 POPULATION)						
	Anoka (195,998)	Carver (37,046)	Dakota (194,274)	Hennepin (941,411)	Ramsey (459,784)	Scott (43,784)	Washington (113,571)
Ethylene Oxide	686	130	680	3,295	1,609	153	397

METHODOLOGY

1. Determine county population.

2. Apply per capita emission factor of 3.5 lb ethylene oxide/1000 persons.
   From: Procedures for Estimating and Allocating Area Source Emissions of Air Toxics. March 1989.

Apportioning

Apportion laboratory ethylene oxide emissions by population.

References

Same as for hospital ethylene oxide sterilizers.

IV. INDUSTRIAL COOLING TOWERS

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR INDUSTRIAL COOLING TOWERS						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Chrome + 6	18	9	5*	24	18	4	47**

* Chrome emissions from Koch Refinery were subtracted because they were included in the TRI data.
** Chrome emissions from Ashland Petroleum were subtracted because they were included in the TRI data.

METHODOLOGY

1) Determine number of employees in industries likely to use hexavalent chrome in cooling towers. Those SIC codes are:

petroleum refining	291
chemical manufacturing	281,282,286,287
primary metals	331,332,333
textile finishing	223,226
tobacco	211,212,213
tire and rubber	301,302,304,306
glass manufacturing	321,322
utilities	491

Employment data are from County Business Patterns, 1986.

County Business Patterns do not give employment totals for SIC codes with fewer than 50 employees but includes them in the next broader SIC group. If individual data are not available, the total employment for each group is estimated by determining the broad SIC group employment total and then subtracting out the product of the broad SIC group employment total times the ratio of the number of establishments in SIC codes that are not being counted over the total number of establishments in the broad SIC group. This can be illustrated as:

$$\text{Total Employment in SIC Group} = \text{Broad SIC Group Employment Total} - \left[\text{Broad SIC Group Employment Total} \times \frac{\text{Number of Establishments in SIC Codes without Employment Totals}}{\text{Number of Establishments in Broad SIC Group}} \right]$$

This methodology probably overestimates employment and is therefore a

conservative method.

2) Apply appropriate emission factors to estimated employment totals for each SIC code group, for each county.

3) Sum emissions for all SIC code groups for each county.
Emission factors from: Locating and Estimating Air Emissions From Sources of Chromium (Supplement). August 1989.

4) Subtract chrome emissions from the above SIC codes that were reported to the TRI from the county totals.

Apportioning

Apportion county industrial cooling tower emissions by industrially zoned areas.

References

1) U.S. Environmental Protection Agency, "Analysis of Air Toxics Emissions, Exposures, Cancer Risks and Controllability in Five Urban Areas,"January 1989.

2) U.S. Environmental Protection Agency, Procedures for Estimating and Allocating Area Source Emissions of Air Toxics," March 1989.

3) U.S. Environmental Protection Agency, "Locating and Estimating Air Emissions from Sources of Chromium," EPA-450/4-84-007g, March 1984.

4) County Business Patterns, 1986.

V. COMFORT COOLING TOWERS

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR COMFORT COOLING TOWERS COUNTY (1980 POPULATION)						
	Anoka (195,998)	Carver (37,046)	Dakota (194,274)	Hennepin (941,411)	Ramsey (459,784)	Scott (43,784)	Washington (113,571)
Chrome + 6	39	7	38	186	91	9	22

METHODOLOGY

1) Determine population of each county. From: 1980 Census Population Data.

2) Multiply population by upper-bound Minnesota emission factor estimate of .000198 lb/yr/person. Emission factor from: February 22, 1990 telephone conversation with Ron Myers, OAQPS.

Note - According to Ron Myers, OAQPS:
After February 20, 1990 distribution of chrome containing corrosion inhibitors will be prohibited. After May 18, 1990, comfort cooling towers will be prohibited from using chrome containing rust inhibitors. Therefore, after May 1990, chrome emissions from comfort cooling towers essentially will be gone.

Apportioning

Apportion county comfort cooling tower emissions by population.

References

References are the same as for industrial cooling towers.

VI. CHROME PLATING

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR CHROME PLATING						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Chrome + 6	517	276	467	3,954	1,424	552	323

METHODOLOGY

1) Determine number of employees in the following SIC codes:

Hard chrome plating
- 3471
- 35 (except 357)
- 37

Decorative chrome plating
- 3471
- 34 (except 3471)
- 357
- 36 (except 3679)
- 3679
- 3751
- 38

Chromic acid anodizing
- 3471
- 3676
- 3721, 3724, 3728, 3761, 3764, 3769

Derive county emission estimates using the following ratio for each SIC code:

$$\frac{\text{Nationwide Emissions}}{\text{Nationwide Employment}} = \frac{\text{County Emissions}}{\text{County Employment}}$$

Employment data are from County Business Patterns, 1986.

County Business Patterns do not give employment totals for SIC codes with fewer than 50 employees but includes them in the next broader SIC group. If individual data are not available, the total employment for each group is estimated by determining the broad SIC group employment total and then subtracting out the product of the broad SIC group employment total times the ratio of the number of establishments in SIC codes that are not being counted over the total number of establishments in the broad SIC group.

This can be illustrated as:

$$\text{Total Employment in SIC Group} = \text{Broad SIC Group Employment Total} - \left[\text{Broad SIC Group Employment Total} \times \frac{\text{Number of Establishments in SIC Codes without Employment Totals}}{\text{Number of Establishments in Broad SIC Group}} \right]$$

This methodology probably overestimates the employment and is therefore a conservati method.

Nationwide emission estimates are from :

> J. Vandenberg, et al, "Exposure and Risk Assessment of Chromium Electroplaters".

Apportioning

Apportion county hexavalent chrome plater emissions by industrially zoned areas.

References

1) U.S. Environmental Protection Agency, "Analysis of Air Toxics Emissions, Exposures, Cancer Risks and Controllability in Five Urban Areas,"January 1989.

2) U.S. Environmental Protection Agency, Procedures for Estimating and Allocating Area Source Emissions of Air Toxics," March 1989.

3) U.S. Environmental Protection Agency, "Locating and Estimating Air Emissions from Sources of Chromium," EPA-450/4-84-007g, March 1984.

4) J. Vandenberg, A. Smith, K. Blanchard et al, "Exposure and Risk Assessment of Chromium Electroplaters," in Proceedings of the 1989 A&WMA Annual Meeting and Exhibition, Air & Waste Management Association, 1989, 89-161.5

5) County Business Patterns, 1986.

VII. SURFACE COATING

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR SURFACE COATING						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Trichloroethylene	792	106	318	3,523	1,235	106	205
Methylene Chloride	30,864	4,117	12,388	137,345	48,160	4,133	8,002

METHODOLOGY

1) Determine employment in SIC code groups that are likely to perform surface coating:

painting contractors	1721
millwork, plywood	243, 244
furniture and fixtures	25
paper and allied products	26
fabricated metal products	34
machinery	35
electrical equipment	36
transportation	37
top and body shop	7531
auto refinishing	7535

Employment data from: County Business Patterns, 1986

2) Apply appropriate emission factors to determine the quantity of trichloroethylene and methylene chloride emitted in each county.

Emission factors from: Procedures for Estimating and Allocating Area Source Emissions of Air Toxics, March 1989.

3) Subtract out emissions accounted for in point source inventory.

a) Locate facilities with SCC = 402------ (surface coating) on emissions inventory system/point source subsystem in the 7-county metro area.

b) Look up each of the facilities in the Minnesota Directory of Manufacturers (1987/1988) and determine the employment for each facility. Note: Two facilities were not included in the Directory and therefore were not subtracted from the total emissions.

c) Subtract the employment totals for each listed facility from the county totals. Employment totals for each facility were given as a range such as 100-249. To be conservative, the low end of the range was subtracted from the county total.

Apportioning

Apportion county surface coating emission by industrial and commercially zoned area.

References

1) Procedures for Estimating and Allocating Area Source Emissions of Air Toxics, USEPA, RTP, NC. March 1989

2) County Business Patterns, 1986.

3) Minnesota Directory of Manufacturers, 1987/88..

VIII. DEGREASING

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR DEGREASING COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Perchloroethylene	96,535	12,039	29,251	348,470	171,518	9,507	11,044
Trichloroethylene	92,648	30,576	74,288	1,024,620	296,280	24,144	28,048
Methylene Chloride	116,455	14,524	35,287	537,054	206,910	11,468	13,323

METHODOLOGY

1) Determine employment totals by county for SIC codes 34-39. (From: County Business Patterns, 1986)

2) Apply employee based emission factors for perchloroethylene, trichloroethylene, and methylene chloride. (From: Procedures for Estimating and Allocating Area Source Emissions of Air Toxics, March 1989)

3) Subtract out emissions accounted for in point source emission inventory (Those sources included in NEDS - method will not account for emissions determined through TRI data.)

Apportioning

Apportion county degreasing emissions by commercial and industrial zoned area.

References

1) Procedures for Estimating and Allocating Area Source Emissions of Air Toxics, March 1989.

2) Pandullo, R.F., et al, "Survey of Trichloroethylene Emission Sources," Radian Corp., RTP, NC, July 1985, EPA/450-3-85/021.

3) Survey of Perchloroethylene Emission Sources, USEPA, OAQPS. June 1985, EPA/45/3-85/017.

4) Survey of Methylene Chloride Emission Sources, Radian, USEPA, OAQPS, June 1985, EPA/45/3-85/015.

5) County Business Patterns, 1986.

IX. COMMERCIAL/CONSUMER SOLVENT USE

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR COMMERCIAL/CONSUMER SOLVENT USE COUNTY (1980 POPULATION)						
	Anoka (195,998)	Carver (37,046)	Dakota (194,274)	Hennepin (941,411)	Ramsey (459,784)	Scott (43,784)	Washington (113,571)
Perchloroethylene	21,560	4,075	21,370	103,555	50,576	4,816	12,493
Trichloroethylene	1,548	293	1,535	7,437	3,632	346	897
Methylene Chloride	133,279	25,191	132,106	640,159	312,653	29,773	77,228

METHODOLOGY

1) Determine county population.
   From: 1980 Census

2) Apply emission factors for perchloroethylene (.11 lb/yr/capita), trichloroethylene (.0079 lb/yr/capita), and methylene chloride (.68 lb/yr/capita).
   From: Procedures for Estimating and Allocating Area Source Emissions of Air Toxics, March 1989.

Apportioning

Apportion county commercial/consumer solvent emissions by population.

References

1) USEPA, Procedures for Estimating and Allocating Area Source Emissions of Air Toxics. Office of Air Quality Planning and Standards, Research Triangle Park, NC. March 1989.

2) USEPA, Compilation and Speciation of National Emissions Factors for Consumer/Commercial Solvent Use. Office of Air Quality Planning and Standards, Research Triangle Park, NC. April 1989.

X. SMALL COMMERCIAL INCINERATORS

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR SMALL COMMERCIAL INCINERATORS						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
POM	950	209	1,254	7,619	2,926	285	494
B(a)P	25	6	33	201	77	8	13

METHODOLOGY

1) MPCA Division of Air Quality maintains a log of all known incinerators. According to Todd Biewen, MPCA Incinerator Team Enforcement Staff, the list for Hennepin County is the most complete of all the counties and represents approximately 75% of the county's operating incinerators. This listing includes commercial, grocery, hospital, industrial, institutional, and nursing home incinerators. The SIC codes most likely to have small incinerators are:

manufacturing	20-39
wholesale trade	50-51
retail trade	52-59
educational	82
nursing homes	805

(This list was determined from looking at the list of incinerators. The above list of SIC codes does not include incinerators in apartment buildings.)

2) Sum the number of establishments in the above SIC codes for each county. Assuming that the 301 establishments with small incinerators in Hennepin County represent 75% of establishments with small commercial incinerators, it is possible to derive an activity factor in the following way:

401 incinerators / 12,124 establishments in the above SIC codes (Hennepin) =.033 incinerators per establishment in SIC codes 20-39, 50-59, 82, and 805.

3) Apply above factor to the total number of establishments in each county to arrive at the estimated number of incinerators in each county.

4) According to Anne Jackson, MPCA staff assigned to writing rules for incinerator emissions, the average commercial incinerator burns 150 lb per hour in four hour batches (600 lb per batch) The incinerators operate five days per week, 52 weeks per year (260 days per year) and average two batches per day. Thus, the average commercial incinerator burns 312,000 pounds of waste per year (142 Mg per year).

5) Multiply the estimated number of incinerators in each county by the average

quantity of waste burned to arrive at the estimated quantity of waste burned in small commercial incinerators in each county.

6) Apply emission factors:
   22,014 mg POM/Mg waste burned
   573 mg B(a)P/Mg waste burned

   From: Toxic Air Pollutant Emission Factors- A Compilation for Selected Air Toxic Compounds and Sources. EPA-450/2-88-006a. October 1988.

Apportioning

Apportion county commercial incinerator emissions by industrially and commercially zoned area.

References

1) Toxic Air Pollutant Emission Factors - A Compilation for Selected Air Toxic Compounds and Sources. EPA-450/2-88-006a. October 1988.

XI. WASTE OIL COMBUSTION

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR WASTE OIL COMBUSTION						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Arsenic	1	--	1	6	3	--	1
B(a)P	--	--	--	1	--	--	--
Benzene	1	--	1	2	1	--	--
Beryllium	1	--	1	6	3	--	1
Cadmium	--	--	--	2	1	--	--
Chrome + 6	--	--	--	--	--	--	--
Formaldehyde	54	10	54	261	128	12	32
Mercury	396	75	394	1,901	929	88	229
Methylene Chloride	1,034	196	1,028	4,966	2,426	231	599
Perchloroethylene	3	1	3	17	8	1	2
Trichloroethylene	3	1	3	14	7	1	2

METHODOLOGY

1) Determine quantity of waste oil combusted in the metro area.
   From: Feasibility Study on Long-Term Management Options for Used Oil in Minnesota. Minnesota Waste Management Board. October 1987.

According to the report cited above:

- o 12.3x10e6 gallons of used oil was generated/yr by automotive and industrial sources.
- o 6.4x10e6 gallons of used oil was collected by used oil haulers and 95% was combusted at asphalt plants.
- o 1.67x10e6 gallons of used oil was recycled/reused onsite by service stations, industry, and farmers.

The majority of asphalt plants in the metro area have permits and therefore their emissions will be included in the study as point sources.

Assume that the 1.67x10e6 gallons recycled/reused onsite is mainly combusted in small boilers/space heaters. This is probably a reasonable assumption as using used oil for road oiling (a previously popular use for used oil) is now illegal.

2) Apportion used oil to the county level by population.

Anoka	1.65x10e5 gallons/yr
Carver	3.12x10e4 gallons/yr
Dakota	1.64x10e5 gallons/yr
Hennepin	7.92x10e5 gallons/yr
Ramsey	3.87x10e5 gallons/yr
Scott	3.68x10e4 gallons/yr
Washington	9.55x10e4 gallons/yr

3) Apply emission factors:

Pollutant	Emission Factor* lb/1000 gallons burned
Arsenic	.007
Benzene	.003
Cadmium	.002
Perchloroethylene	.021
Trichloroethylene	.018

* Emission factors from: Toxic Air Pollutant Emission Factors for Selected Air Toxic Compounds and Sources. October 1988. These emission factors are specific to waste oil combustion in small boilers/space heaters.

Pollutant	Emission Factor** lb/1000 gallons burned
Beryllium	.0075
B(a)P	.00084
Chrome+6	.000062
Formaldehyde	.33
Lead	7.9
Mercury	1.7-3.1 (used average = 2.4)

Methylene Chloride	.031-12.5 (used average = 6.27)

** Emission factors from: Procedures for Estimating and Allocating Area Source Emissions of Air Toxics. March 1989.
These emission factors are for general waste oil combustion.

Apportioning

Apportion emissions by commercial and industrially zoned areas.

References

1) Feasibility Study on Long-Term Management Options for Used Oil in Minnesota. Minnesota Waste Management Board. October 1987.

2) Toxic Air Pollutant Emission Factors - A Compilation for Selected Air Toxic Compounds and Sources. EPA-450/2-88-006a. October 1988.

3) Procedures for Estimating and Allocating Area Source Emissions of Air Toxics, USEPA, RTP, NC. March 1989.

XII. INDUSTRIAL AREA SOURCE HEATING

A. DISTILLATE OIL

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR INDUSTRIAL DISTILLATE OIL HEATING						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Arsenic	28	10	38	194	127	8	49
B(a)P	--	--	--	1	--	--	--
Beryllium	1	--	1	7	5	--	2
Cadmium	42	14	57	292	190	12	74
Chrome	17	6	23	118	77	5	30
Chrome + 6	.07	.02	.09	.48	.32	.02	.12
Formaldehyde	60	21	82	417	272	17	105
Nickel	19	7	26	132	86	5	33
POM	25	9	34	174	113	7	44

B.NATURAL GAS

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR INDUSTRIAL NATURAL GAS HEATING						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Formaldehyde	47	20	142	493	322	21	58

METHODOLOGY FOR AREA SOURCE HEATING ESTIMATES

1) Determine quantity of industrial fuel consumed for each county from NEDS data base (1985 estimates).

2) Subtract out industrial fuel consumption contained in EIS point source data base.

3) Apply appropriate emission factors.
   Emission factors from: Procedures for Estimating and Allocating Area Source Emissions of Air Toxics. March 1989.
   Emission factors for natural gas combustion from: Locating and Estimating Air Emissions From Sources of Formaldehyde. EPA-450/4-84-007e.

Apportioning

Apportion industrial heating emission by industrially zoned area.

References

1) Procedures for Estimating and Allocating Area Source Emissions of Air Toxics, USEPA, RTP, NC. March 1989.

2) Locating and Estimating Air Emissions From Sources of Formaldehyde. EPA-450/4-84-007e.

XIII. COMMERCIAL/INSTITUTIONAL HEATING

A. DISTILLATE OIL

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR COMMERCIAL/INSTITUTIONAL DISTILLATE OIL HEATING						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Arsenic	17	4	29	248	86	6	12
B(a)P	--	--	--	2	1	--	--
Beryllium	--	--	--	1	--	--	--
Cadmium	26	6	44	374	129	9	18
Chrome	18	4	30	260	90	6	12
Chrome + 6	.07	.02	.12	1.07	.37	.03	.05
Formaldehyde	37	9	63	537	186	12	26
Nickel	41	10	69	585	203	13	28
POM	16	4	27	228	79	5	11

B. RESIDUAL OIL

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR COMMERCIAL/INSTITUTIONAL RESIDUAL OIL HEATING COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Arsenic	2	1	4	29	10	1	1
B(a)P	--	--	--	1	--	--	--
Beryllium	--	--	--	--	--	--	--
Cadmium	3	1	6	47	16	1	2
Chrome	2	1	4	32	11	1	2
Chrome + 6	.01	--	.02	.13	.05	--	.01
Formaldehyde	4	1	7	62	21	1	3
Nickel	35	8	60	505	175	11	24
POM	2	--	3	26	9	1	1

C. NATURAL GAS

POLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR COMMERCIAL/INSTITUTIONAL NATURAL GAS HEATING COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
Formaldehyde	360	59	592	6,426	2,060	97	200

METHODOLOGY FOR AREA SOURCE HEATING ESTIMATES

1) Determine quantity of commercial/institutional fuel consumed for each county from NEDS data base (1985 estimates).

2) Subtract out commercial/institutional fuel use contained in EIS point source database.

3) Apply appropriate emission factors.
   Emission factors from: Procedures for Estimating and Allocating Area Source Emissions of Air Toxics. March 1989.
   Emission factors for natural gas combustion from: Locating and Estimating Air Emissions From Sources of Formaldehyde. EPA-450/4-84-007e.

Apportioning

Apportion county commercial/institutional heating emissions by commercially zoned area.

References

Same as for Industrial Area Source Heating.

IV. RESIDENTIAL HEATING

.. DISTILLATE OIL

OLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR RESIDENTIAL DISTILLATE OIL HEATING						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
rsenic	2	1	2	8	5	1	3
(a)P	--	--	--	1	--	--	--
eryllium	3	1	2	10	7	1	3
admium	16	8	13	58	38	5	20
hrome	2	1	1	6	4	1	2
hrome + 6	.01	--	--	.02	.02	--	.01
ormaldehyde	145	70	119	518	343	41	175
ickel	154	74	126	550	364	44	186
OM	3,600	1,730	2,952	12,874	8,528	1,025	4,354

. NATURAL GAS

OLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR RESIDENTIAL NATURAL GAS HEATING						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
ormaldehyde	2,885	477	3,173	16,293	7,056	649	1,458

:V. RESIDENTIAL WOODBURNING

OLLUTANT	TWIN CITIES METROPOLITAN AREA AIR EMISSIONS (LB/YR) FOR RESIDENTIAL WOODBURNING						
	COUNTY						
	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Washington
rsenic	12.67	2.53	12.67	59.56	29.14	2.53	7.61
ɜryllium	.01	--	.01	.06	.03	--	.01
admium	1.98	.40	1.98	9.32	4.56	.40	1.19
ɔrmaldehyde	90,924	18,185	90,924	427,556	209,230	18,185	54,584
ɜrticulate	1,367,287	273,463	1,367,287	6,429,561	3,146,326	273,463	820,822
ɔM	10,589	2,118	10,589	49,794	24,365	2,118	6,357

IETHODOLOGY

) Determine quantity of wood consumed in the metropolitan area.
From: Minnesota Residential Fuelwood Study.

) Apportion wood consumed to the county level by population

) Assume that 65% of the wood consumed in the metro area is burned in fireplaces and 35% is burned in woodstoves.
From: Minnesota Residential Fuelwood Study.

) Emission factors:

a. POM

fireplaces: 0.065 lb/ton wood consumed
woodstoves: 0.584 lb/ton wood consumed

From: Locating and Estimating Air Emissions from Sources of POM

b. Formaldehyde

fireplaces: 3.0 lb/ton wood consumed
woodstoves: .48 lb/ton wood consumed

From: Toxic Air Pollutant Emission Factors for Selected Air Toxic Compounds and Sources.

c. Particulates

fireplaces:	28 lb/ton wood consumed
woodstoves:	39 lb/ton wood consumed

From: AP-42

d.Metals

Arsenic (As)	
fireplaces:	2.6x10e-4 lb/ton w
woodstoves:	3.6x10e-4 lb/ton w
Beryllium (Be)	
fireplaces:	2.9x10e-7 lb/ton w
woodstoves:	2.9x10e-7 lb/ton w
Cadmium (Cd)	
fireplaces:	7.1x10e-5 lb/ton w
woodstoves:	none

From: Procedures for Estimating and Allocating Area S
Air Toxics. March 1989.

5) Apply appropriate emission factors to the quantity of w
fireplaces and woodstoves for each county. Add the e
total.

6) Calculate risk using the comparative potency approac
burning from residential sources the particle unit risk e
1.0x10e-5 lifetime risk/ug/cubic meter.

Apportioning

Apportion county emissions by single-family residentiall

References

1) U.S. Environmental Protection Agency. Locating and E
From Sources of Polycyclic Organic Matter (POM). EP
of Air Quality Planning and Standards. Research Trian
September 1987.

2) Minnesota Department of Natural Resources. Minneso
Survey 1988-1989.

3) U.S. Environmental Protection Agency. Compilation o
Factors. AP-42. Office of Air Quality Planning and S
Triangle Park, NC. September 1985.

4) U.S. Environmental Protection Agency. Toxic Air Pollutant Emission Factors-
A Compilation for Selected Air Toxic Compounds and Sources.EPA-450/2-88-006a
Office of Air Quality Planning and Standards. Research Triangle Park, NC.
October 1988.

5) U.S. Environmental Protection Agency. Procedure for Estimating and
Allocating Area Source Emissions of Air Toxics. March 1989.

APPENDIX C

DETERMINATION OF HEXAVALENT CHROME EMISSIONS

DETERMINATION OF HEXAVALENT CHROME EMISSIONS

Methodology

There is very little information on hexavalent chrome emissions from point sources other than chrome platers and cooling towers. However, the point source inventory procedure resulted in estimates of total chrome emissions. Therefore, there arose the question of whether or not some portion of those total chrome emissions were hexavalent chrome.

In general the staff approach was to not overestimate hexavalent chrome emissions. Hexavalent chrome is a very potent carcinogen. Therefore the emissions estimation step should be dealt with carefully. Staff believed that it was better to underestimate the risk at this time because information on hexavalent chrome is very limited and often conflicting. Overestimating emissions could have led to misleading results with the potential for a significant overestimation of risk. It is recommended that the derivation of better data on hexavalent chrome emissions and ambient data be pursued in order to address this issue with more accuracy in the future.

The following steps were taken to address this question:

(1) The inventory of total chrome emissions was reviewed with respect to the derivation of the total chrome values. EPA NEDS speciation profiles that were applied in the inventory procedure to develop total chrome levels were reviewed. This resulted in splitting sources of chrome emissions into two major groupings; those associated with chrome as a mineral (mining or materials handling of aggregates), and those associated with heated processes (fuel combustion, asphalt production, etc.).

(2) Much of the total chrome estimates derived from speciation factors were based on average mineral handling factors. Research has indicated that the most common mineral form of chrome is trivalent. There are minerals based on the hexavalent chromate ion (CrO4)-2, however they are less common [ref. 1 page 82].

Staff contacted the Minnesota Geological Survey regarding the potential for chrome to occur in local bedrocks [4]. The response was that it would be unlikely for there to be significant levels of chrome in local bedrocks. Therefore it was assumed that there was no hexavalent chrome from these mineral handling based operations. Examples include coal cleaning and lime manufacturing.

(3) Waste incineration (municipal solid waste and sludge incineration) was separated from other combustion processes and a factor of 0.5% of total chrome was applied. Incineration was handled separately because specific hexavalent chrome factors were available. The factor used was derived by averaging the four available hexavalent chrome factors [ref 2, page 3-82 and 3-83]. This resulted in a factor of 0.5%.

(4) For fuel combustion related processes other than municipal solid waste and sludge incineration, it was assumed that 1% of the total chrome was present as hexavalent chrome . The 1% figure is based on the following:

(a) There are four available hexavalent chrome estimates for coal burning:

0.0034 lbs/10E12 BTU - Coal Fired Utility Boiler with Fabric Filter [ref 2, page 3-73].

1.5-5.5 lbs/10E12 BTU - Coal fired indus./comm. boiler with 2 mechanical collectors in series. [ref 2. page 3-74]

0.41% of uncontrolled chrome - coal fired boiler [ref 3, page 20]

0.15% of controlled chrome - coal fired boiler [ref 3, page 20]

(The third factor was applied for area source heating [sources not included as point sources], under item K. of Appendix B.)

(b) The first two factors were applied to sources in the inventory to determine what percent of total chrome they represented. The results show that applying the first factor to appropriate sources estimates 0.02% to be hexavalent chrome, and the second to be 7.3% hexavalent chrome. Therefore, factors ranging from 0.02% - 7.3% are available in the literature for combustion associated processes.

(c) Given the recommendation for use of the 0.41% and 0.15% values for hexavalent chrome emissions in reference #3, combined with consideration of the 7.3% and 0.02% values, a compromise estimate of 1% was used for this study.

(5) For process sources, research has indicated that none of the processes considered here rely on a hexavalent form of chrome as input to the process. Steel production, and therefore related metals processing relies on trivalent chromites [ref. 1, page 93]. Chrome from asphalt roofing manufacture and asphalt production apparently is derived from impurities in the asphalt itself. Therefore, in general, there is no reason to assume that

there are particularly high levels of hexavalent chrome occurring in these processes.

What these process sources have in common is a melting, heating or a combustion type process. Therefore, it is reasonable to apply the same 1% value as derived for fuel combustion.

(6) Where chrome emission estimates included both mineral based and heated process based values, each estimate and its source were examined in more detail. Where emissions estimates for chrome were primarily based on mineral processing, it was assumed that hexavalent chrome emissions were zero. Examples here included normal superphosphate production and glass manufacturing. Where emissions estimates for chrome were primarily based on heated process emissions, it was assumed that hexavalent chrome emissions were 1% of the total. This included steel production and cement manufacture.

There was one exception to the above discussion and that was for asphalt concrete production. Asphalt concrete emissions estimates for chrome are primarily mineral based. This seems inappropriate since there are significant emissions of particulates from dryer operations (a heated process) in asphalt concrete production. However, the inventory does include chrome emissions estimates for asphalt roofing production which are primarily based on heated process operations.

It is reasonable to assume that total chrome emissions for asphalt roofing manufacture and asphalt drum operations are more similar than asphalt drum operations and mineral handling operations since drum emissions are largely related to the processing of hot asphalt. A comparison of these two values shows that the asphalt roofing production estimate is approximately 3 times greater than the mineral based asphalt concrete production value.

After consideration of these data, the total chrome emissions estimate for asphalt concrete was maintained and the 1% hexavalent chrome emissions estimate was applied to it. This resulted in maintaining the total chrome emissions estimates while applying some level of hexavalent emissions estimate for asphalt concrete production.

A summary of the results of this process follows this discussion. It lists the SCCs and the assigned percentages used to determine hexavalent chrome emissions from total chrome emissions.

References:

1. Jerome O. Nriagu, Evert Nieboer, "Chromium in the Natural and Human Environments", 1988.

2. U.S. Environmental Protection Agency. "Toxic Air Pollutant Emission Factors - A Compilation For Selected Air Toxic Compounds and Sources". EPA-450/2-88-006a. Office of Air Quality Planning and Standards. Research Triangle Park, NC. October 1988.

3. U. S. Environmental Protection Agency. "Analysis of Air Toxics Emissions, Exposures, Cancer Risks and Controllability in Five Urban Areas. Volume 1, Base Year Analysis Methods and Results." Review Draft Report. January 1989.

4. Minnesota Geologic Survey, Telephone Contact, Jim Miller, 627-4780, March 21, 1991.

SUMMARY - HEXAVALENT CHROME DETERMINATION FOR POINT SOURCES

SCC DESCRIPTION

I. FUEL COMBUSTION - ASSUME 1% OF TOTAL CHROME IS HEXAVALENT CHROME FOR THE FOLLOWING SCC CODES:

101002	Bit./Subbit. Coal Combustion - Utilities
101004	Residual Oil Combustion - Utilities
101005	Distillate Oil Combustion - Utilities
101008	Coke Combustion - Utilities
102002	Bit./Subbit. Coal Combustion - Industrial
102004	Residual Oil Combustion - Industrial
102007	Process Gas Combustion - Industrial
103002	Bit./Subbit. Coal Combustion - Comm./Inst...
306001	Petroleum Industry Process Heaters

II. HEATED PROCESS SOURCES - ASSUME 1% OF TOTAL CHROME IS HEXAVALENT CHROME FOR THE FOLLOWING SCC CODES:

303009	Steel Production
304001	Secondary Aluminum
304003	Gray Iron Foundries
304007	Steel Foundries
305001	Asphalt Roofing
305002	Asphaltic Concrete Production
305006	Cement

III. USE 0.5% FOR THE FOLLOWING SCC CODES:

501005	Municipal Sludge Incineration
502001	Commercial/Institutional Solid Waste Incinerator
502005	Commercial/Institutional Sludge/Medical Waste Incinerator
503001	Industrial Solid Waste Incinerator
503005	Industrial Sludge/Hazardous Waste Incinerator

APPENDIX D

DETAILED EMISSIONS INVENTORY AND INDICENCE DATA

POLLUTANT	ROAD VEHICLES	WOOD STOVES & FIREPLACES	CHROME PLATERS	HEATING	SMALL COMM. INCINERATORS	MISC. AREA SOURCES	POINT SOURCES	TOTAL
WOOD STOVE PM	0	6204.39	0	0	0	0	0	6204.39
DIESEL PM	3025.36	0	0	0	0	0	0	3025.36
BENZENE	1602.2	0	0	0	0	22.090168	228.549	1852.839
METHYLENE CHLORIDE	0	0	0	0	0	1152.5437	423.202	1575.746
FORMALDEHYDE	623.678	412.586	0	20.976	0	0.249932	440.472	1497.962
PERCHLOROETHYLENE	0	0	0	0	0	1030.43	82.7985	1113.229
TRICHLOROETHYLENE	0	0	0	0	0	722.4	319.164	1041.564
GASOLINE PM	182.7	0	0	0	0	0	0	182.7
1,3-BUTADIENE	146.838	0	0	0	0	0	6.5731	153.4111
STYRENE	0	0	0	0	0	0	39.4178	39.4178
POLYC ORG MATTER	0	0	0	16.2755	6.23106	0	0	22.50656
ETHYLENE OXIDE	0	0	0	0	0	6.63068	4.23486	10.86554
ETHYLENE DIBROMIDE	0	0	0	0	0	0.338837	9.04919	9.388027
ETHYLENE DICHLORIDE	0	0	0	0	0	3.39427	5.82054	9.21481
CHROME + 6	0	0	3.40787	0.00142	0	0.23451	0.058696	3.702496
ACETALDEHYDE	0	0	0	0	0	0	3.66811	3.66811
VINYL CHLORIDE	0	0	0	0	0	0	2.4062	2.4062
ACRYLONITRILE	0	0	0	0	0	0	2.3165	2.3165
CADMIUM	0	0.008995	0	0.689921	0	0.001361	1.04925	1.749527
ARSENIC	0	0.057475	0	0.420031	0	0.005443	0.95663	1.439579
CARBON TETRACHLORIDE	0	0	0	0	0	0	0.448403	0.448403
PAHCS	0	0	0	0.002722	0.164656	0.0005	0.00492	0.172798
CHLOROFORM	0	0	0	0	0	0	0.060019	0.060019
PROPYLENE OXIDE	0	0	0	0	0	0	0.029662	0.029662
BERYLLIUM	0	0.00005	0	0.019963	0	0.005443	0.00127	0.026726
BENZO(A)PYRENE	0	0	0	0	0	0	0.0004	0.0004
DIOXIN (TCDD-TET)	0	0	0	0	0	0	9E-08	9E-08
TOTAL	5580.776	6617.04252	3.40787	38.38556	6.395716	2938.32484	1570.281	16754.61

Appendix D - Table VII-1D: Numeric Excess Incidence Results

POLLUTANT	ROAD VEHICLES	WOOD STOVES & FIREPLACES	CHROME PLATERS	HEATING	SMALL COMM. INCINERATORS	MISC. AREA SOURCES	POINT SOURCES	TOTAL
DIESEL PM	58.9976	0	0	0	0	0	0	58.9976
GASOLINE PM	34.145	0	0	0	0	0	0	34.145
WOOD STOVE PM	0	33.2151	0	0	0	0	0	33.2151
1,3-BUTADIENE	26.8471	0	0	0	0	0	0.332193	27.17929
CHROME+6	0	0	23.3447	0.006744	0	1.68591	0.042378	25.07973
POM	0	0	0	13.6134	6.58602	0	0	20.19942
BENZENE	8.6737	0	0	0	0	0.12116	0.363254	9.158114
FORMALDEHYDE	5.2939	2.87103	0	0.14621	0	0.0005	0.246089	8.557729
ARSENIC	0	0.128978	0	1.108312	0	0.012525	0.440436	1.690251
TRICHLOROETHYLENE	0	0	0	0	0	0.803963	0.240503	1.044466
CADMIUM	0	0.006854	0	0.744732	0	0.0006	0.143987	0.896173
ETHYLENE OXIDE	0	0	0	0	0	0.438169	0.369931	0.8081
PERCHLOROETHYLENE	0	0	0	0	0	0.409017	0.025494	0.434511
METHYLENE CHLORIDE	0	0	0	0	0	0.344554	0.053528	0.398082
ETHYLENE DIBROMIDE	0	0	0	0	0	0.047216	0.341337	0.388553
PAHCS	0	0	0	0.0009	0.170566	0.0002	0	0.171666
ETHYLENE DICHLORIDE	0	0	0	0	0	0.056357	0.011525	0.067882
BERYLLIUM	0	0	0	0.020766	0	0.006248	0	0.027014
ACRYLONITRILE	0	0	0	0	0	0	0.002057	0.002057
STYRENE	0	0	0	0	0	0	0.0004	0.0004
ACETALDEHYDE	0	0	0	0	0	0	0.0001	0.0001
TOTAL	133.9573	36.221962	23.3447	15.64106	6.756586	3.926419	2.613212	222.4612